Science & Mechanics

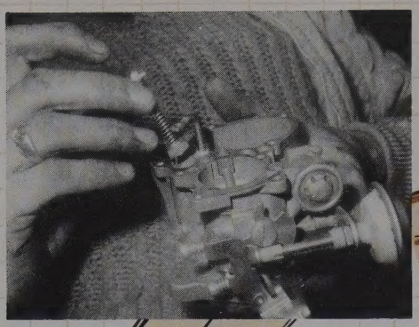
Complete HANDYMAN ENCYCLOPEDIA

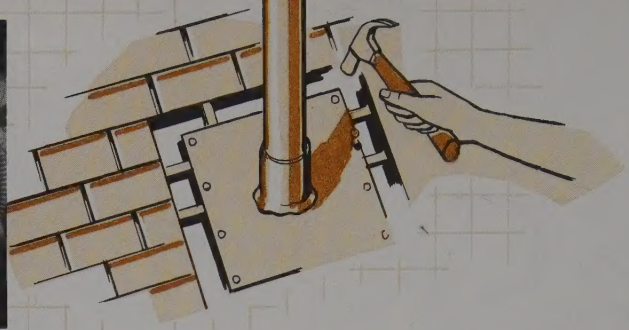
do-it-yourself

4

CARBURETORS
CLUTCH

Complete Handyman do-it-yourself Encyclopedia





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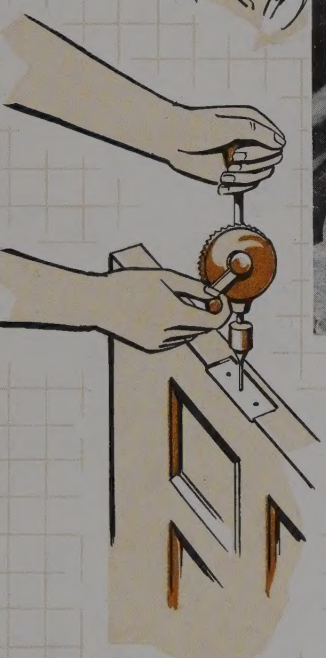

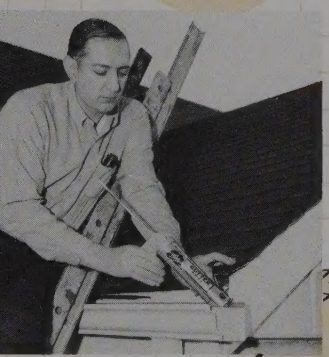

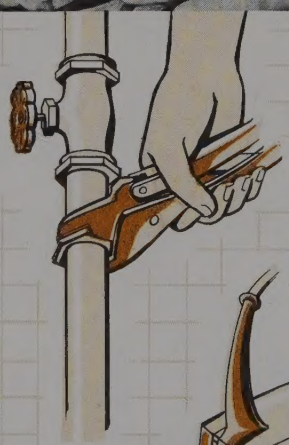

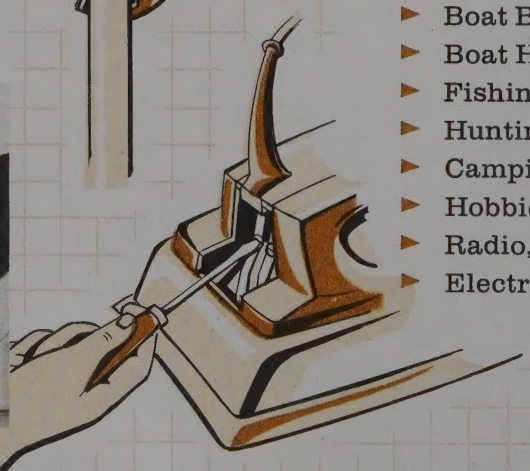

Complete Handyman yourself Encyclopedia

A COMPILATION OF NEW AND PREVIOUSLY PUBLISHED SPECIAL INTEREST PROJECTS AND MANUALS FOR THE REPAIR AND CARE OF HOMES, AUTO, APPLIANCES, HOBBY EQUIPMENT.

by the editors of

Science & Mechanics

4

CARBURETORS
CLUTCH

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Put New Life in Your Carburetor

Keeping your carburetor in shape can spare your car a long list of auto ailments

A LIST OF MALFUNCTIONS caused by a sick carburetor reads like a "Who's Who of Auto Ailments." It includes hard starting, flooding, delayed acceleration, poor gas mileage, stalling, rough running, fouled spark plugs, and gas leaks at the carburetor.

Not all of these problems, however, result only from an ailing carburetor. For this reason you should make sure spark plugs, ignition parts, compression, and timing are all in good condition before beginning carburetor service. In short, make sure your engine is correctly tuned, because your carb depends on proper operation of the rest of the engine.

Make no mistake about one thing, a carburetor would probably function properly forever if it were not for dirt that is present in the air sucked into it and in the gas. This dirt builds up in the carb and causes the engine to lose power while drinking up an increasing amount of gas. Or, dirt can strike suddenly and cause the engine to stop running without warning. In either case, the results are the same: loss of power, engine sputter, stalling, and wasted gas.

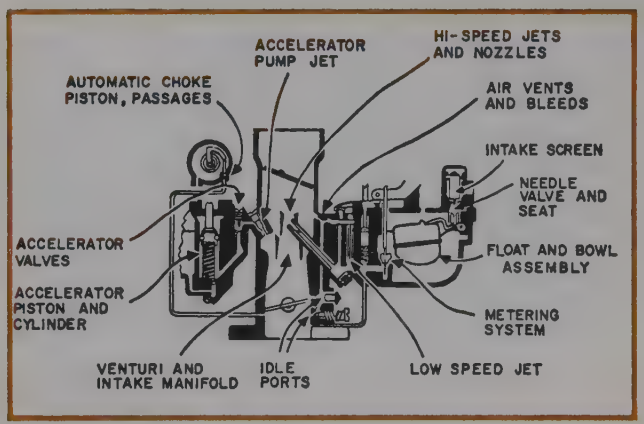
There are several ways to remove this dirt. First, a cleaner can be added to the gas tank. If this cleaner is added three or four times a year from the time the car is new, it does a fairly effective job. The cleaner enters all parts and orifices of the carb and cleans them out while driving.

Another way to keep your carb clean is to introduce the solvent directly into the carb through a gravity-feed kit. These can be purchased at most auto supply outlets or accessory stores. It contains adapters, a flexible hose line, and a container of cleaner.

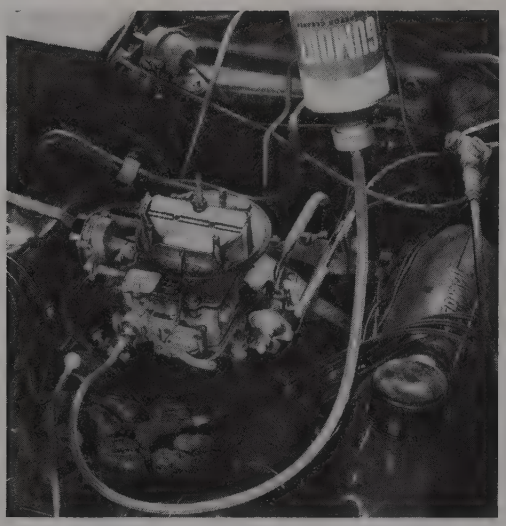
To use this cleaner, disconnect the gas line at the carb, then block off the flow of gas through the line with the universal block-off fitting provided with the kit. Attach the hose to the carb at the gas inlet port, using the adapter that fits the hole. Start the engine and run it at various speeds. Every so often, place the palm of your hand over the carb to block off air and force the cleaner into all gas and air passages.

The most effective method to really clean the carb when the other ways don't correct

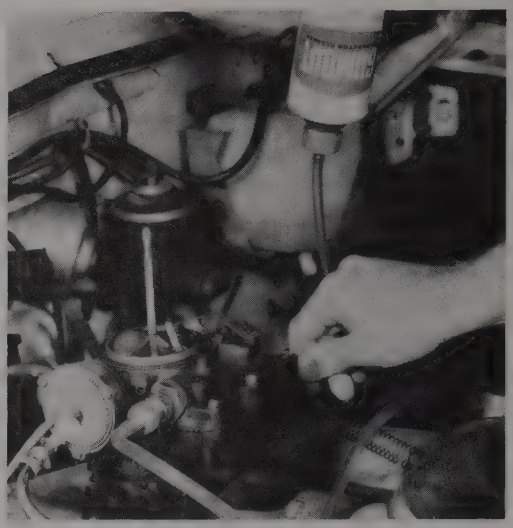
Cutaway of a simple one-barrel carburetor.



car layout, model: see model car layout
carpet tile: see tile, carpet

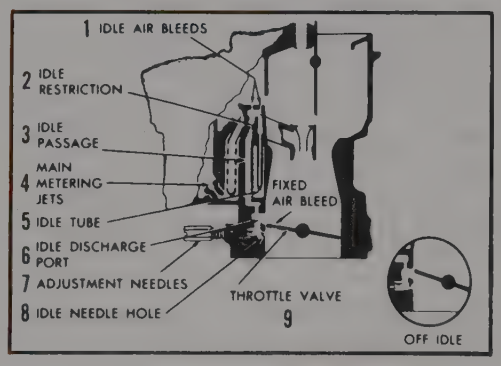


Cleaning kit is attached to the fuel inlet of the carburetor. The fuel line has been disconnected and plugged. Attach hose at gas inlet.



Run engine at various speeds with kit attached, actuating throttle linkage at carb. Palm over carb forces cleaner into other passages.

How the Idle System Works



The idle system consists of the idle tubes, idle passages, idle air bleeds, idle adjustment needles and idle discharge holes.

In the curb idle speed position, the throttle valve is slightly open, allowing a small amount of air to pass between the wall of the carburetor bore and the edges of the throttle valve.

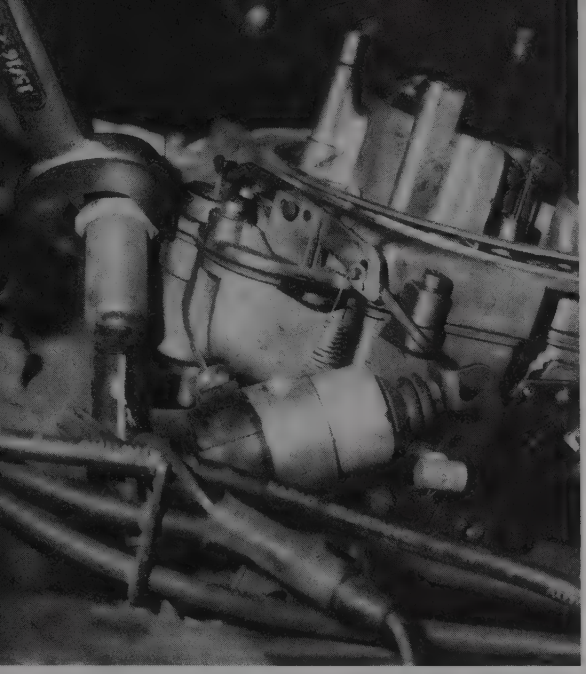
The idle needle hole is in the high vacuum area below the throttle valves while the fuel bowl is vented to atmospheric pressure.

The fuel is drawn from the bowl through the main metering jets into the main well. The fuel is metered by the idle fuel metering orifice at the lower tip of the idle tube and travels up the idle tube. When the fuel reaches the top of the idle tube, it is mixed with air through two idle air bleed holes. This mixture moves through the horizontal idle passage through a restriction and down the vertical idle passage to the four idle discharge holes located just above the throttle valves where more air is added to the mixture. It then passes through the idle needle holes and into the bore of the carburetor.

In addition to this mixture of fuel and air, air enters the bore of the carburetor through the slightly opened throttle valve. For smooth operation the air from the bore and the air-fuel mixture from the idle needle hole must combine to form the correct final mixture for curb idle engine speed.

The position of the idle adjusting needle regulates the amount of air fuel mixture admitted to the carburetor bore. Except for this variable at the idle adjustment needle, the idle system is specifically calibrated for low engine speeds.

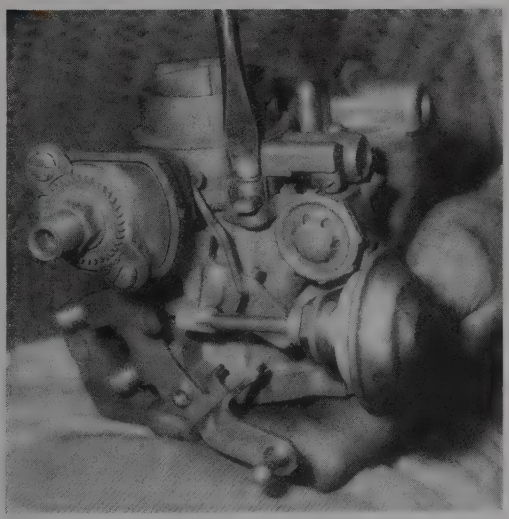
As the throttle valves are opened, a pressure differential change occurs. Opening of the valve progressively exposes the idle discharge holes to manifold vacuum and the air flow, with the result that they deliver additional air-fuel mixture for off-idle engine requirements.



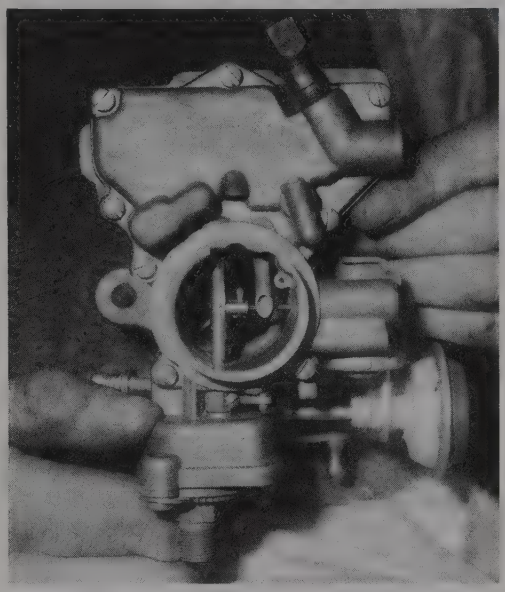
the ailment is to take it off the intake manifold, disassemble it, and clean each part. This way you can inspect each part, change if necessary, and make internal adjustments.

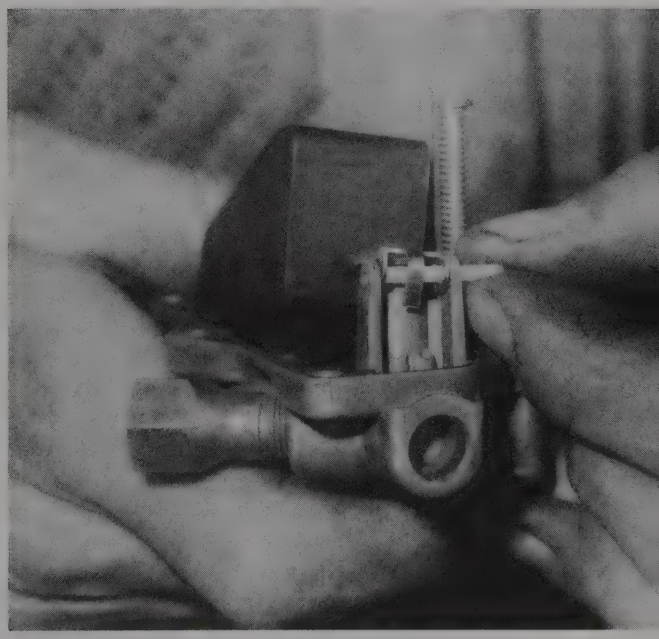
Modern carburetors are somewhat complex. Unless you have a reasonable amount of experience, you should buy a rebuilt. With experience, however, you can tackle a one-barrel or even a two-barrel carburetor, as explained in this article.

Hold carburetor vertical while removing.

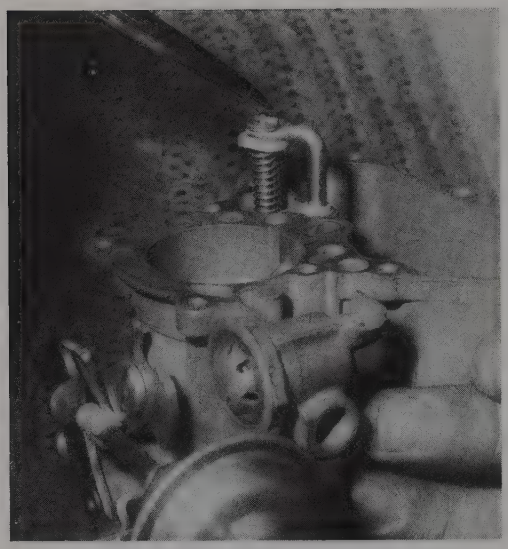


Replacement of carburetor begins with disconnection of fuel line. Disassembly of carb begins with removal of screws on top. After they are out, carb top can be removed.





Float is disconnected by removing hinge pin. Directly under float tab is the needle and seat assembly, which controls fuel inlet.



This is the accelerator pump, which should be removed. Job starts with pulling of a cotter pin on this particular carburetor; on others a C-clip is used.

The illustrations here are based on a one-barrel carburetor. Most one-barrels are reasonably simple and similar.

A carburetor rebuilding kit often contains rather complete information to guide you over any difficult items.

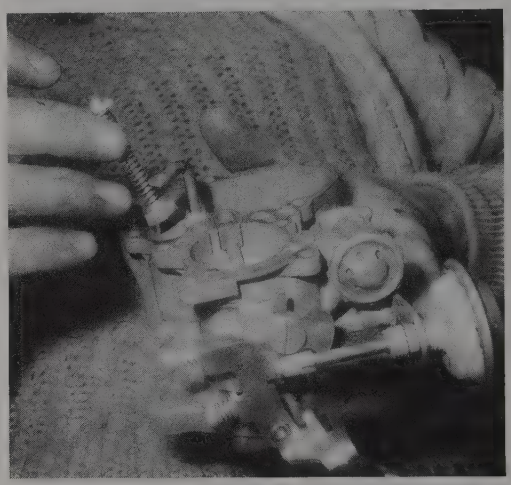
Prices of carburetor kits vary by several dollars, and the only way to decide on the best buy is to find out what each kit contains. More expensive kits contain instructions, a gauge for measuring the all-important float level, and internal replaceable parts, including gaskets, jets, accelerator pump, power valves, and needle and seat valve. Cheaper kits may only contain gaskets and a needle and seat valve.

The most complete kits are only about $15 for a four-barrel, which is about a third of the price of a quality rebuilt. So if you're doing it yourself, don't skimp.

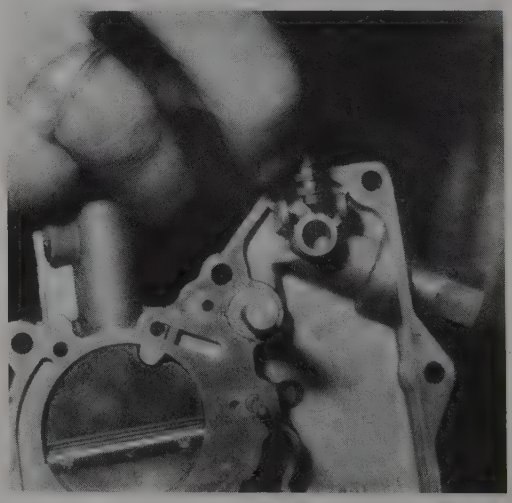
When buying your kit, refer to the name and model number of your carb (found on the nomenclature plate attached to it). If you can't find this plate, give the salesman the make and year of your car, type of engine (six or eight cylinders), and kind of transmission (manual or automatic).

To aid in diagnosing the cause of your malfunctioning carb, remove it from the engine without draining fuel from the bowl. You can check the bowl for dirt and find out if the float has a hole in it.

Remove the fuel inlet nut with an open-



Above: Pull accelerator pump out completely. Caution: there are balls inside that are part of check valve assembly. Invert carb very slowly so you can see where they come from along with any other parts that might fall out. Below: Needle, held in fingers, is removed from seat. On this carburetor, the seat is not replaceable as it is built into the top of carb. On most carbs, it is a replaceable screw-in fitting.



end wrench, then use the needle-nose pliers to disconnect the spring clips that hold the throttle linkage. Loosen any vacuum lines, then remove the carb from the engine by taking out the nuts that connect the throttle body to the intake manifold.

Disconnect the accelerator pump from its external linkage, then unscrew the cover fasteners and lift the cover from the bowl. Discard the gasket separating the cover assembly from the lower part of the carb.

Disconnect the float by removing the hinge pin. (On some carbs, the float is hinged to the cover, on others it is hinged to a flange inside the fuel bowl.)

Performance of all parts of a carb is influenced by the fuel supply in the float bowl. This fuel level must remain constant despite varying speeds of the engine and demands on the carburetor. When the car is driven at high speed, the greater rate of fuel consumption causes the float to lower, the needle valve to open, and more fuel to enter the bowl.

As the throttle closes when the engine idles, thus reducing the demand for fuel, the rising float closes the needle valve, stopping the flow of fuel.

The smallest drop of dirt on the needle valve or a sticky float can cause the carb to flood, resulting in a rich mixture that wastes fuel and causes hard starting.

Check the float by shaking it close to your ear: if there is a sloshing sound, it has a leak and should be replaced. Inspect the lower surfaces of the float bowl to see that the small sealing beads are not damaged, because this can result in air or fuel leaks at that point. Don't try to solder the opening, because it will make the float heavier.

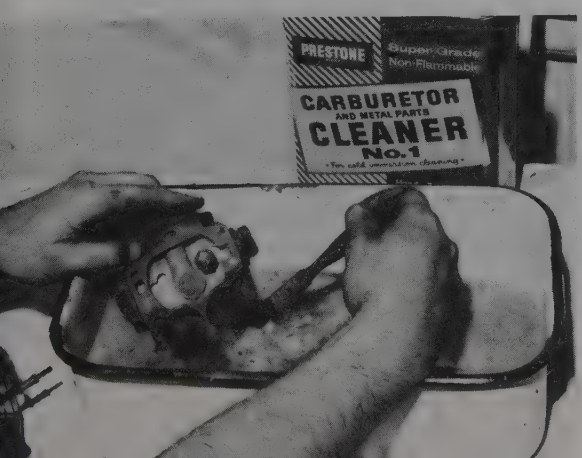
A float that is thrown off balance by anything inside it or any extra weight will lie low in the bowl and keep the needle valve open for a longer period. This lets too much gas into the bowl, resulting in an over-rich mixture.

Free the accelerator pump plunger from the pump arm by removing the pin or clip that retains it. Pull the pump plunger straight out and discard it. (When installing a new plunger, soak its leather seal first in light engine oil for about 10 minutes. This will ease the process of fitting it into its bore.)

Remove the power valve, which is normally held by screws. (On multi-barrel carbs, there is more than one power valve.) Take off the choke assembly.

Dunk the carburetor in a medium-duty solvent and agitate it every few minutes for a total of thirty minutes. Do not attempt

Left: Carburetor should be cleaned in a suitable solvent, agitating periodically. Use of a brush to wash away dirt also is good practice. Below: Measuring float level may be done with machinist's ruler, in this case attached to feeler gauge. This float top is perfectly level with top of carb (cover inverted), so measurement can be taken anywhere. On other carbs, measurements are different for heel and toe of carb.



to dry a carburetor with compressed air; allow it to air-dry instead. (Some carbs have an ignition advance or fuel control diaphragm in the carburetor and this could be damaged by compressed air.)

Install a new power valve, gaskets, jets, idle mixture needles, needle and seat valve, and accelerator pump. The only tools you will need are screwdrivers, needle-nose pliers and perhaps a wrench to change the seat part of the needle and seat valve.

When reassembling, screw the idle mixture adjusting needles and springs into the throttle body until finger-tight, then back out 1½ turns as a preliminary idle adjustment. Put a new throttle body gasket in position and tighten screws evenly and securely.

Every carburetor has some unique design features. On some carbs, the accelerator pump has an external linkage with several holes for seasonal adjustment. On others, the power valve is removed from the outside of the bowl. To prevent fuel from percolating when the engine is shut off after operation in hot weather, some carbs have a special spring-loaded vent.

If your carb has some unrecognizable features that require special attention or parts replacement, maintenance information should be contained in the instructions in your rebuilding kit.

As a carburetor ages, the float level rises naturally. This is due primarily to wear of the float lever pin. As the float rises higher to shut off fuel entering the float bowl, the carb tends to give a richer mixture to the engine. If necessary, adjust the float by bending the tang at the rear of the float, then visually check alignment. Decrease float drop by bending it toward the needle seat, or away from the seat to increase.

All types of carburetors—no matter how many barrels—have only one throttle adjusting screw. Two- and four-barrel units, however, have two idle adjustment screws—one for each idle system.

Warm the engine to operating temperature and have the choke valve completely open when adjusting. Start the engine and let it idle. If it stalls, turn the throttle screw in until the engine is running steady without any foot pressure on the accelerator.

The idle mixture should be adjusted to give a smooth idle. Missing is a sign of too lean an idle mixture while rolling or loping indicates too rich a mixture. Turning the screw in leans the mixture. It may be necessary to readjust the idle speed and mixture after the air cleaner is installed.

(Note: late model smog-controlled cars usually have a plastic limiter that restricts the movement of the mixture screw. An acceptable mixture adjustment should be possible within its limits.)

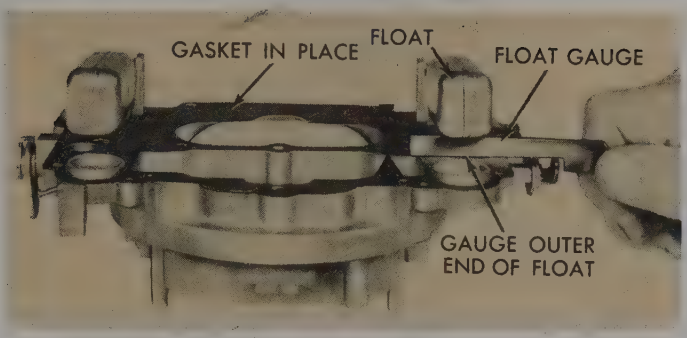
Turn the idle adjusting screw in slowly until the engine is about to stall. At this point, turn the screw out about a half-turn. If the engine seems to race, turn the throttle adjusting screw out slowly until the speed comes down. Once you touch the throttle adjusting screw, you must find the best adjustment for the idle adjusting screw.

Best way to check out your work, if you don't have a tachometer, vacuum gauge, and exhaust analyzer, is by sight, sound, and feel.

Listen to the engine to determine if it is operating at an even and smooth speed. The exhaust sound coming from the muffler should sound like the engine is firing steadily. Check for excessive vibration by seeing how the engine rests on the mounts, and feel the fender.

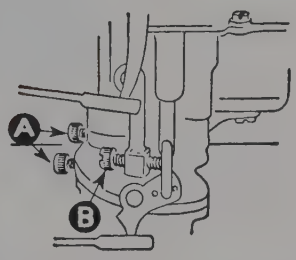
Cars with automatic transmissions should be adjusted with the least pull on the engine. Be sure the handbrake is set and transmission is in DRIVE position when you adjust the idling and throttle screws. P.W.

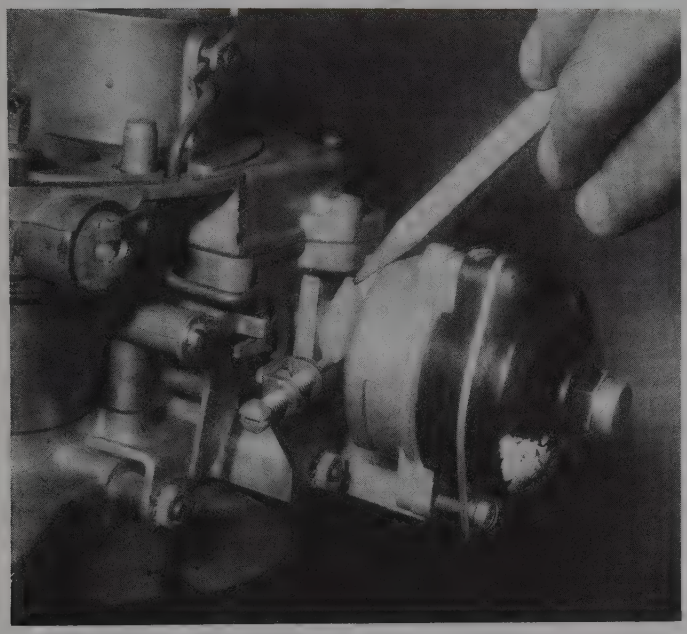
See also: ENGINE; IGNITION SYSTEM, AUTO; PARTS REPLACEMENT, ENGINE; TUNE-UP, ENGINE.



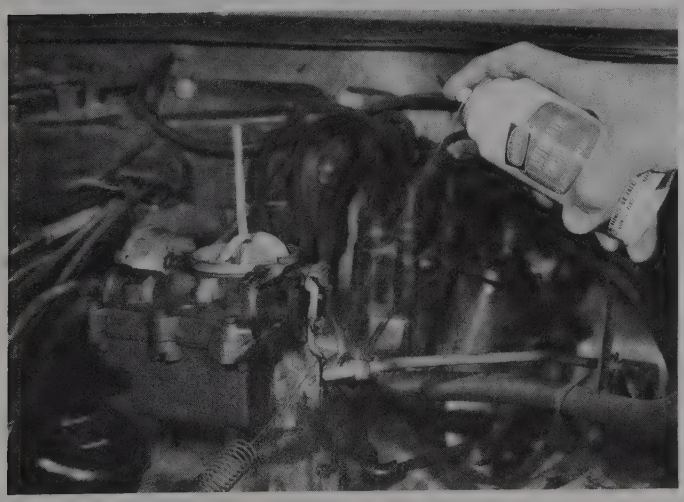
On this four-barrel carb, float level measurement is made with gasket in place and gauge at outer end of float (toe end).

Two- and four-barrel carb has two mixture screws labeled "A," in addition to throttle stop speed screw (also called idle speed screw) labeled "B."

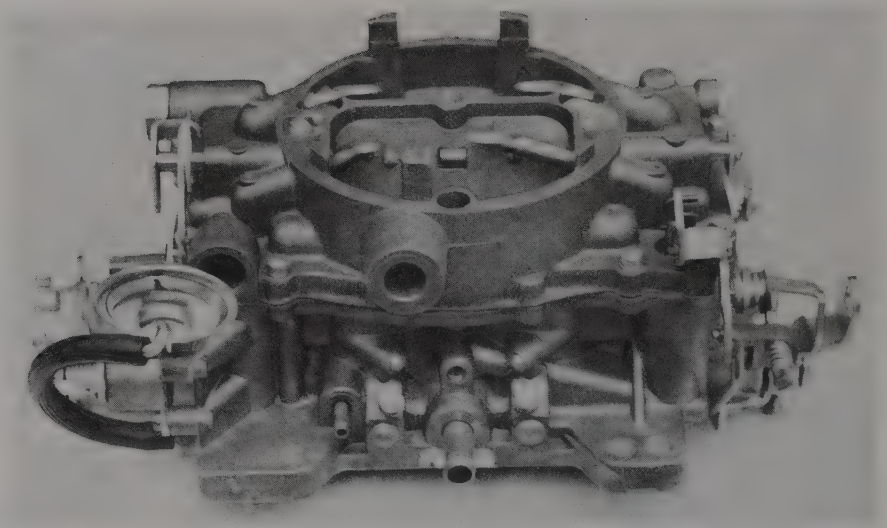




In addition to idle mixture screws and idle speed screw, carburetor also has a fast idle screw, which should not be confused with them. Fast idle screw rides against a metal or plastic curved or stepped surface called the fast idle cam. Fast idle speed should be 1,500 to 1,800 rpm when engine is running immediately after a cold start. If it is not within that range, turn the fast idle screw (clockwise to increase speed, counterclockwise to decrease).



Once you have your carb clean and running right, keep it that way by spraying all external linkage with automatic choke cleaner.



How to Rebuild a Four-barrel Carburetor

This job sounds difficult, but widely available kits make it easier than you probably think it is

FOUR-BARREL CARBURETORS are a lot simpler than most people believe. All it takes to rebuild a four-barrel carb is patience, care, carb solvent and a rebuild kit. Several manufacturers make rebuild kits for four-barrel carbs. Make sure that the kit you buy has complete diagrams and specifications for the carb that is on your engine.

Most carbs can be identified by telling the dealer who sells the rebuild kits the make, model and year of your car and what engine you have, as well as if the car has a stick or automatic transmission. Most carbs also have code tags attached with all the vital information stamped on them so that identification is simplified.

Rather than give detailed specifications for any one carb, we have gathered up material that shows how the Carter AFB four-barrel carb works and how to make adjustments on it. To round out our coverage and give GM owners assistance, we also have a view of a typical 4GC Rochester four-barrel carb and instructions on how to perform adjustments on it. Special tools are helpful but not really needed. If you have a good eye and measure carefully you can do a topnotch job.

Before you take the carb off the engine (you should not attempt to rebuild the carb on the engine) clean the carb of grease and grime. Kerosene and a paint brush will do an excellent job of cleaning the outside of the carb. To clean the inside of the carb you will need special solvent. Some of the well-known brands are Gum-out, Carb Master, Bendix Carb Cleaner and Gunk.

Be careful when you disassemble the carb that you do not lose any parts. Soak

all of the parts, except plastic, rubber or gasket material, in the solvent until the parts are clean. Be careful not to let your hands soak in the carb cleaner as it is a very powerful solvent and will irritate your hands. Most smart mechanics take the parts out of the solvent and flush them with kerosene to make sure that the parts are clean and that they can be handled without irritation. Do not use gasoline to clean the carb as it is very explosive. Be careful when using the carb cleaner. Use it outside or where you have adequate ventilation. Empty coffee cans with the snap-on plastic top make excellent cleaning tanks for carb cleaner.

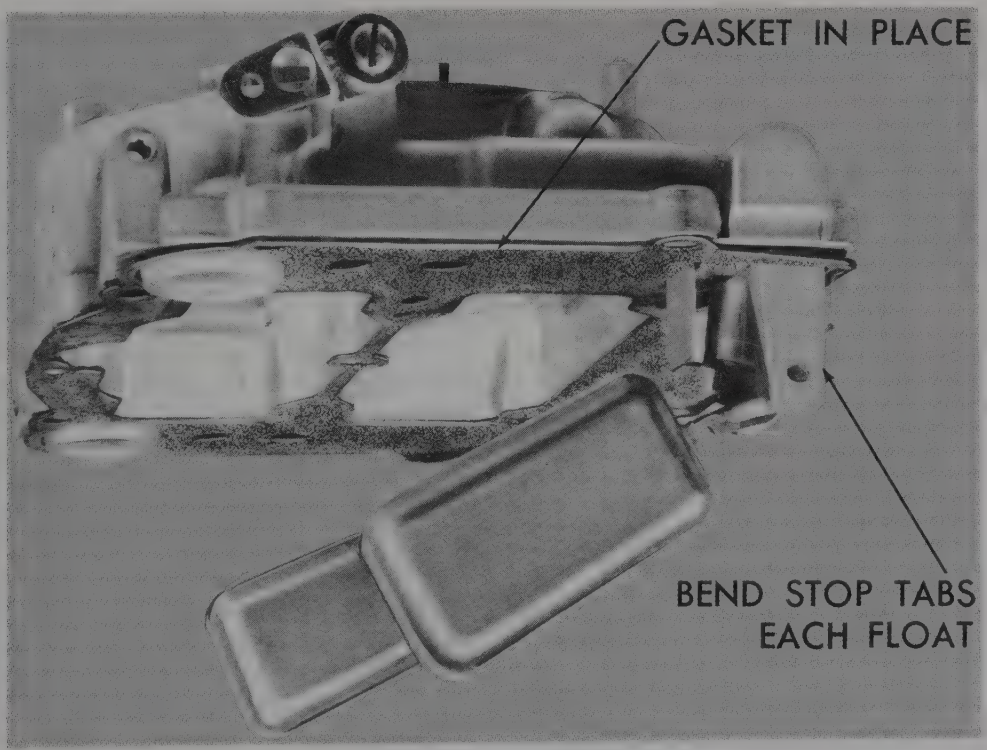
If compressed air is available, it is a good idea to blow out all of the carb passages to make sure that they are clean.

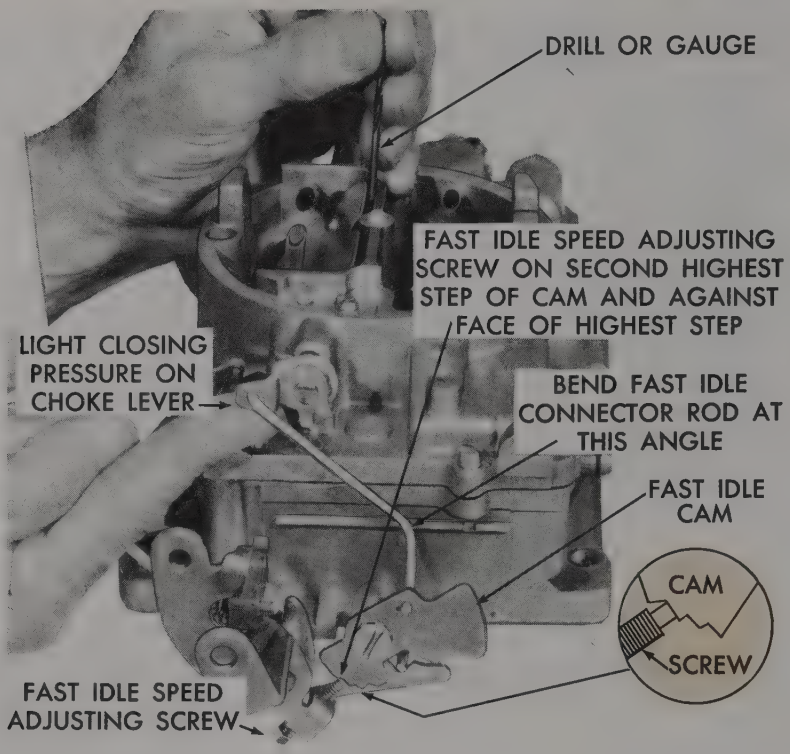
It is not a good idea to take out the main jets as they often vary from the primary and secondary barrels and sometimes from the right to left side.

The purpose of the float circuit is to maintain an adequate supply of fuel at the proper level in the bowl for use by the low speed, high speed, pump and choke circuits. There are two separate float circuits. Each supplies fuel to a primary low-speed circuit and a primary and secondary high speed circuit.

Setting the floats to specifications assures an adequate supply of fuel in the bowls for all operating conditions. Special consideration should be given in service to be sure the floats do not bind in their hinge pin

Float drop setting. Holding air horn in an upright position, measure distance from top of floats at outer end to the air horn gasket as illustrated (see arrows). This measurement should be 3/4-inch. To check float level, invert and measure from top of float to gasket, which should be 7/32-inch at outer end. If float drop adjustment is necessary, bend stop tabs on float levers (toward needle seat reduces drop, away from seat increases drop). If float level adjustment is necessary, bend float arm.




DRILL OR GAUGE
FAST IDLE SPEED ADJUSTING SCREW ON SECOND HIGHEST STEP OF CAM AND AGAINST FACE OF HIGHEST STEP
LIGHT CLOSING PRESSURE ON CHOKE LEVER
BEND FAST IDLE CONNECTOR ROD AT THIS ANGLE
FAST IDLE CAM
CAM
SCREW
FAST IDLE SPEED ADJUSTING SCREW

Fast idle speed cam position. Fast idle speed is set with engine running, but cam position adjustment can be made off the car, assuring that the speeds of each cam step occur at the proper time. With fast idle speed screw in contact with second highest speed step on cam, move choke valve toward closed position with light pressure on choke shaft lever. Insert #28 drill as shown and there should be light drag. To adjust, bend connector rod.

brackets or drag against the inner walls of the bowl.

The intake needle seats of the Carter carb are installed at an angle to provide the best possible seating action of the intake needles. Intake needles and seats are carefully matched during manufacture. Do not use the left needle in the right seat or vice versa. To avoid unnecessary bending, both floats should be reinstalled in their original positions and then adjusted.

The bowls are vented to the inside of the air horn and, on certain models, also to atmosphere. A connecting vent passage effects a balance of the air pressure between the two bowls. Bowl vents are calibrated to provide proper air pressure above the fuel at all times. Baffles are used in the bowls to provide a stable fuel supply for the primary and secondary main jets.

The carburetor bowl and the intake strainer screen should be clean and free of dirt, gum or other foreign matter. To assure a positive seal, the gasket surface of the castings must be free of nicks and burrs. An air or fuel leak at these points can result in a mileage complaint and cutting out on sharp turns or sudden stops. A new air horn gasket should be used when reassembling.

Low-speed circuit. Fuel for idle and early part throttle operation is metered through the low-speed circuit. The low speed circuit is located on the primary side only. Gasoline enters the idle wells through the main metering jets. The low speed jets mea-

sure the amount of fuel for idle and early part throttle operation. The air by-pass passages, economizers and idle air bleeds are carefully calibrated and serve to break up the liquid fuel and mix it with air as it moves through the passages to the idle ports and idle adjustment screw ports. Turning the idle adjustment screws toward their seats reduces the quantity of fuel mixture supplied by the idle circuit.

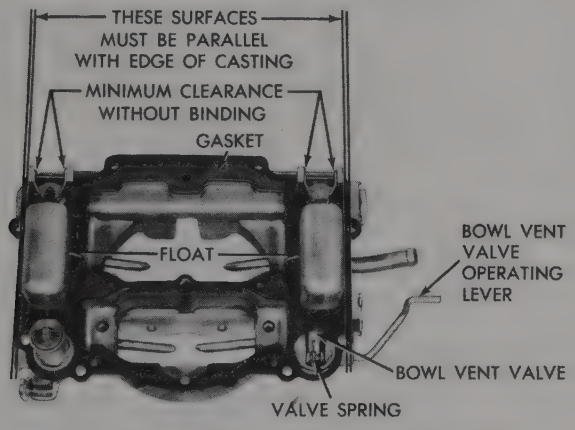
The idle ports are slot shaped. As the throttle valves are opened, more of the idle ports are uncovered, allowing a greater quantity of the gasoline and air mixture to enter the carburetor bores. The secondary throttle valves remain seated at idle.

All by-passes, economizers, idle ports, idle adjustment screw ports, as well as the bore of the carburetor must be clean and free of carbon. Obstructions will cause poor low speed engine operation. Worn or damaged idle adjustment screws or low speed jets should be replaced.

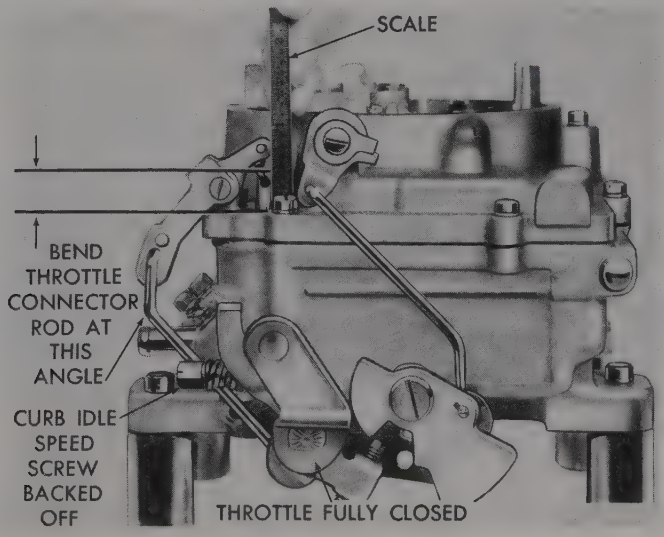
The low speed jet, air bleed, economizer and by-pass bushings are pressed in place. Do not remove in servicing. If replacement is necessary, use a new Venturi assembly. To insure proper alignment of the low speed mixture passage, the primary Venturi assemblies were designed with interlocking bosses so they can only be installed in the proper locations. (When the primary Venturi assemblies are placed in the wrong side of the carburetor, they will not fit all the way into the casting.)

Air leakage at the gasketed surface surrounding the low speed mixture passages or between the flange and manifold may cause poor idle and low speed operation. Tighten Venturi assemblies securely. Always use new gaskets.

To assist in quick hot engine starting on



Float alignment setting. Each float should be parallel to outer cage of air horn casting. If not in alignment, bend float lever by applying pressure to end of float shell with thumb. Below: Accelerator pump adjustment. Move choke valve to wide open position. Back off idle speed screw until throttle valves are fully seated. Measure from top of air horn to top of lever (should be 7/16-inch). To adjust, bend connector rod.



some models, fuel vapor accumulated in the primary and secondary bores is vented to the atmosphere through vent passages above the throttle valves.

Fuel for part throttle and full throttle operation is supplied through the high speed circuit. On the primary side, the position of the step-up rod in the main metering jet controls the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

During part throttle operation, manifold vacuum pulls the step-up piston and rod assembly down, holding the large diameter of the step-up rod in the main metering jet. This is true when the vacuum under the piston is strong enough to overcome the tension of the step-up piston spring. Fuel is then metered around the large diameter of the step-up rod in the jet.

Under any operating condition, when the tension of the spring overcomes the pull of vacuum under the piston, the step-up rod will move up so its smaller diameter or power step is in the jet. This allows additional fuel to be metered through the jet. The step-up rod does not require adjustment.

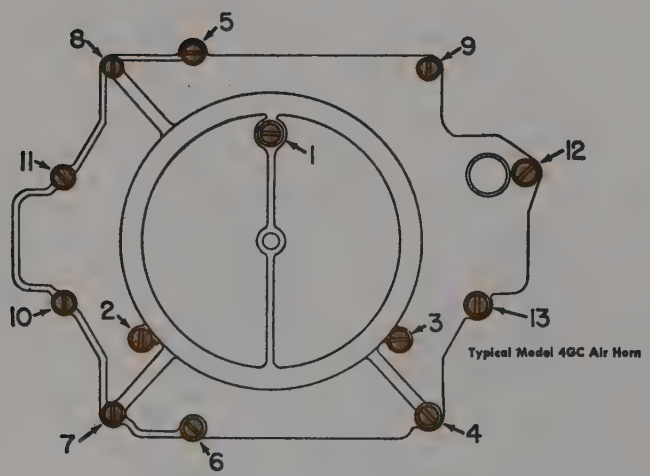
On the secondary side, fuel for the high speed circuit is metered at the main metering jets (no step-up rods used). The main vent tubes on primary and secondary sides mix air drawn through the high speed air bleed with the fuel before it passes out of the nozzles.

A clogged air bleed or main vent tube may cause excessively rich mixtures. The high speed bleed and main vent tubes are permanently installed. If replacement is necessary, use a new Venturi assembly.

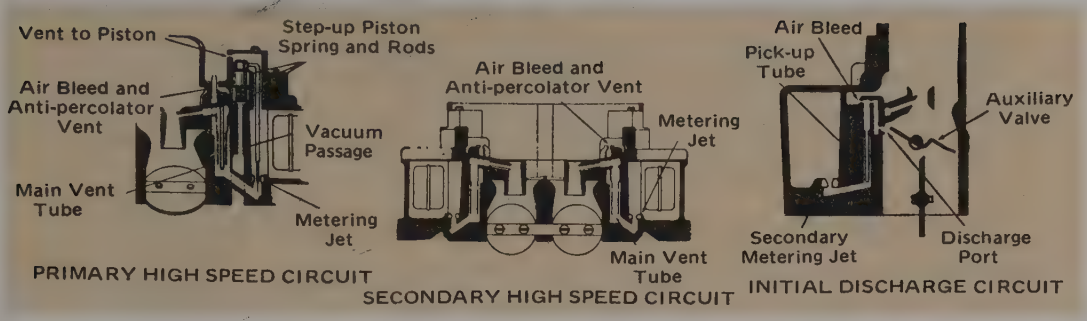
The high speed bleeds also act as anti-percolator vents when a hot engine is stopped or at idling speed. This will help vent fuel vapor pressure in the high speed and idle well before it is sufficient to push fuel out of the nozzles and into the intake manifold.

On models with auxiliary valves, initial discharge ports are incorporated to assist the starting of the fuel flow in the secondary high speed circuit. These ports are located next to the Venturi struts. When the auxiliary valves start to open, the vacuum at the discharge ports pulls fuel into the pick-up tubes. Air bleeds serve to break up the liquid fuel and mix it with air as it moves through the passages to the initial discharge ports where it is discharged into the air stream. As the auxiliary nozzles deliver additional fuel, less fuel flows from the initial discharge ports.

The secondary throttle valves, on some models, are vacuum controlled. This feature provides the added capacity of the second carburetor only when the engine is able to make use of this capacity. When



Proper tightening of carburetor air horn screws is essential to good operation. Loose screws or air horn warpage due to excessive screw tightness can cause poor mileage and momentary flooding. First tighten each screw just enough to compress the lock washer, then follow same order and tighten each screw 1/2 turn more. Here is the tightening sequence for Rochester carb.

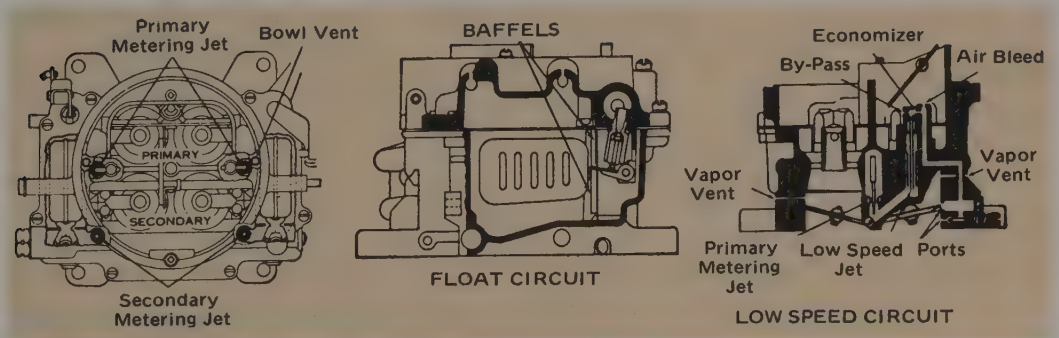


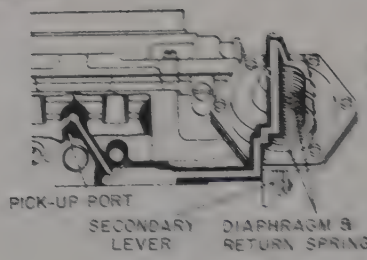
the accelerator is fully depressed, the secondary valves are cracked open manually a few degrees. Air passing through the primary Venturis determines the amount of vacuum applied to the secondary throttle operating diaphragm, by way of the primary vacuum pick-up port. When the vacuum is strong enough to overcome the diaphragm spring, the secondary valves open. A vacuum pick-up port, located in the secondary Venturi, supplies vacuum to overcome the partial loss of vacuum at the primary pick-up port, when the secondary valves open. A mechanical overriding linkage insures that the secondary valves will always close with the primary valves.

Some models use offset valves above the secondary throttle valves. These are called "auxiliary throttle valves." Counterweights are located on the ends of the auxiliary throttle shaft. The auxiliary valve counterweights operate in a recess inside the carburetor body. Throttle valves in the secondary side remain closed, until the primary valves have been opened a predetermined amount. Air velocity through the carburetor controls the position of the auxiliary valves. The auxiliary valves open when the force of the air against the offset valves is able to lift the counterweights.

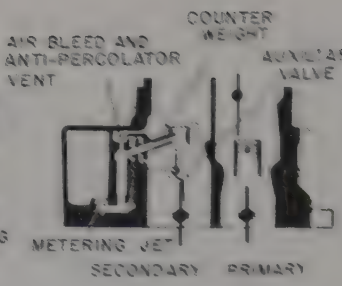
When the accelerator is fully depressed, only the primary high speed circuit will function until there is sufficient air velocity to open the auxiliary valves. When this occurs, fuel will also be supplied through the secondary high speed circuit.

The accelerating pump circuit, located in the primary side, provides a measured amount of fuel necessary to insure smooth engine operation on acceleration at lower car speeds. When the throttle is closed, the pump plunger moves upward in its cylinder and fuel is drawn into the pump cylinder through the intake check. The discharge check is seated at this time to prevent air being drawn into the cylinder. When the throttle is opened, the pump plunger moves downward, forcing fuel out through the discharge passage, past the discharge check, and out of the pump jets. When the plunger moves downward, the intake check

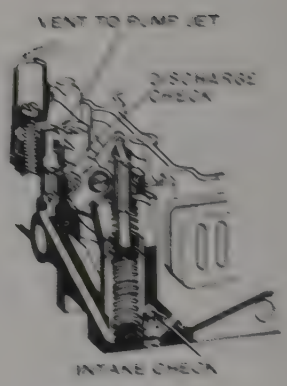




VACUUM OPERATED SECONDARY



AUXILIARY VALVE OPERATION



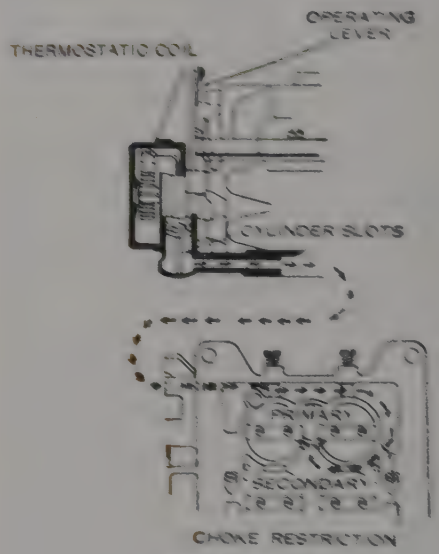
PUMP CIRCUIT

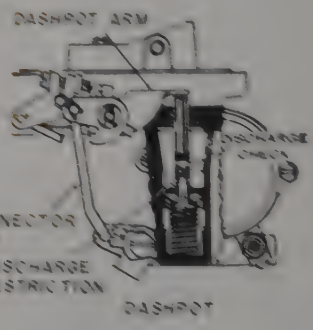
is closed, preventing fuel from being forced back into the bowl.

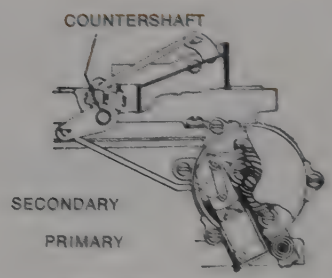
At higher car speeds, pump discharge is no longer necessary to insure smooth acceleration. When the throttle valves are opened a predetermined amount, the pump plunger bottoms in the cylinder eliminating pump discharge.

During the high speed operation, a vacuum exists at the pump discharge ports. To prevent fuel from being drawn through the pump circuit, the pump jets are vented on some models by a cavity between the pump jet restrictions and discharge ports. This allows air instead of fuel to be drawn through the pump discharge ports.

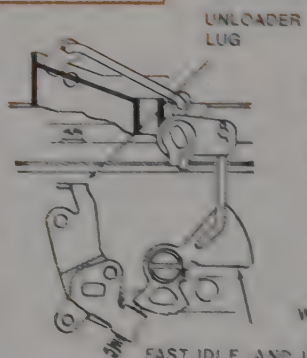
Be sure the pump plunger leather is in good condition and the intake and discharge checks and pump jet are free of lint, gum or other foreign matter. To facilitate service, the intake check ball and seat may be inspected and replaced by removing the screw plug in the face of the flange without complete disassembly of the carburetor.







COUNTERSHAFT LINKAGE



FAST IDLE AND UNLOADER LINKAGE

The climatic control circuit of the Carter AFB carb, located in the primary side, provides the correct mixture necessary for quick cold engine starting and warm-up. When the engine is cold, tension of the thermostatic coil holds the choke valve closed. When the engine is started, air velocity against the offset choke valve causes the valve to open slightly against the thermostatic coil tension. Intake manifold vacuum applied to the choke piston also tends to pull the choke valve open. The choke valve assumes a position where tension of the thermostatic coil is balanced by the pull of vacuum on the piston and the force of air velocity on the offset valve.

When the engine starts, slots located in the sides of the choke piston cylinder are uncovered, allowing intake manifold vacuum to draw warm air through the climatic control housing. This air is heated in a tube running through the exhaust crossover passage, or a manifold stove. The flow of warm air heats the thermostatic coil and causes it to lose some of its tension gradually, until the choke valve reaches full-open position. If the engine is accelerated during the warm-up period, the corresponding drop in manifold vacuum allows the thermostatic coil to momentarily close the choke, providing a richer mixture.

On some models, to combat engine stalling during warm-up on cool humid days, caused by "carburetor icing," heated air from the choke housing is circulated through the passage in the base of the carburetor flange. The heat transferred helps eliminate ice formation at the throttle valve edges and idle ports.

On some models, to permit lower overall height, a choke countershaft over the secondary bores connects the choke linkage to the choke valve.

The choke shaft and fast idle cam must operate freely without any tendency to stick or bind. Remove gum or dirt accumulation on the choke operating parts.

During the warm-up period, it is necessary to provide a fast idle speed to prevent engine stalling. This is accomplished by a fast idle cam connected to the choke linkage. The fast idle adjusting screw on the throttle lever contacts the fast idle cam and prevents the throttle valves from returning to a normal warm engine idle position, while the climatic control is in operation.

If during the starting period the engine becomes flooded, the choke valve may be opened manually to clean out excessive fuel in the intake manifold. This is accomplished by depressing the accelerator pedal to the floor mat and engaging the starter. The unloader projection on the throttle lever contacts the unloader lug on the fast idle cam and in turn partially opens the choke valve.

An internal dashpot is incorporated on some models to slow the closing of the throttle, to prevent stalling on quick deceleration.

When the throttle is opened, the plunger spring pushes the plunger upward. The intake check opens allowing fuel to fill the cylinder below the plunger. When the throttle is closed, the plunger is pushed downward. The intake check is closed and fuel is forced through the discharge restriction, delaying the closing of the throttle valves.

Be sure the plunger leather is in good condition and the intake check and discharge restriction are free of lint, gum or other foreign matter. The plunger shaft must operate freely in its guide in the air horn.

It may be necessary to adjust the dashpot on the car due to engine-transmission combinations and individual driving habits. Be sure dashpot arm does not contact air horn next to plunger shaft at idle. This condition may cause inconsistent idle speeds. P.W.

See also: CHOKE, AUTOMATIC; ENGINE; TUNE-UP, ENGINE.

Car Top Luggage Rack

You'll fully appreciate it when you drive in uncramped comfort. It's a few-evenings project for the handy camper

THE PROBLEM FOR MOST campers is not a matter of getting to the camp site and back—it's finding a place to pack everything. Here's a car top rack for camping gear or luggage which, along with the car trunk, should be adequate in most instances and permit the car's passengers to travel in uncramped comfort.

With hinged top that makes it easy to pack and unpack, the good looking unit shown can be painted to match your car. Dimensions of this particular unit are 3 feet wide by 4 feet long and 13½ inches deep. But you can readily construct such a rack to suit your own needs by varying the dimensions.

A strap at each carrier rail (not shown in the photographs) holds the box securely while traveling.

Begin by assembling the needed material according to the list. Cut out sides A and B from 1 x 12-inch material. Two of each are required. Cut parts G and H from ¼-inch exterior plywood to the dimensions given on the drawing. Use waterproof glue and 3d galvanized common nails to fasten sides A and B to the plywood panels G and H (refer to the exploded view).

Next, following the cutting diagram, cut out all other parts, but check measurements with the previously assembled parts for complete accuracy. Bevel the proper edges and assemble according to the exploded view with glue and 4d finishing nails. Countersink the nails and fill holes with wood filler.

Parts I are ¼-inch plywood strips, 3 inches wide. Fit and glue them into place as indicated in the exploded drawing. They

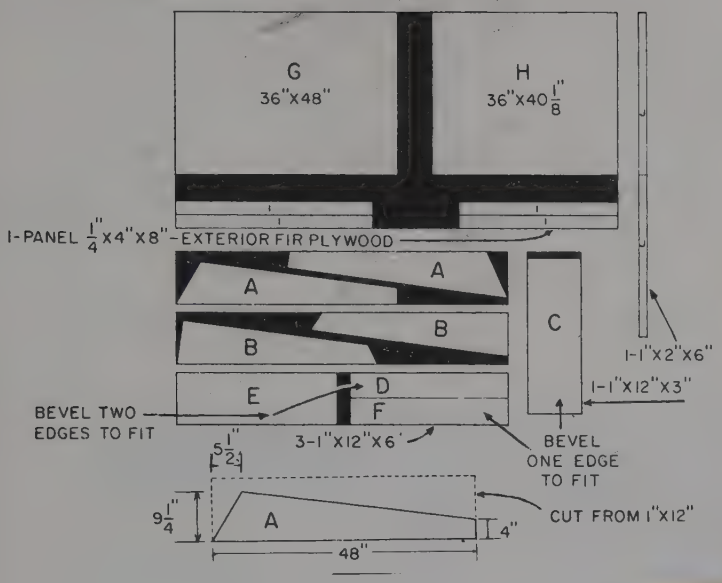
MATERIALS LIST

Quantity	Size and Description	Purpose
1	¼″ 4′x8′ fir plywood (exterior grade)	parts G, H and I
3	1″ 12″x6′ S4S pine or equivalent	parts A, B, D, E and F
1	1″ 12″x3′ S4S pine or equivalent	part C
1	1″ 2″x6′ S4S pine or equivalent	part J
1	28″ light chain with screws	lid stop
1	36″ piano type hinge with screws	
2	suitcase catches with screws	

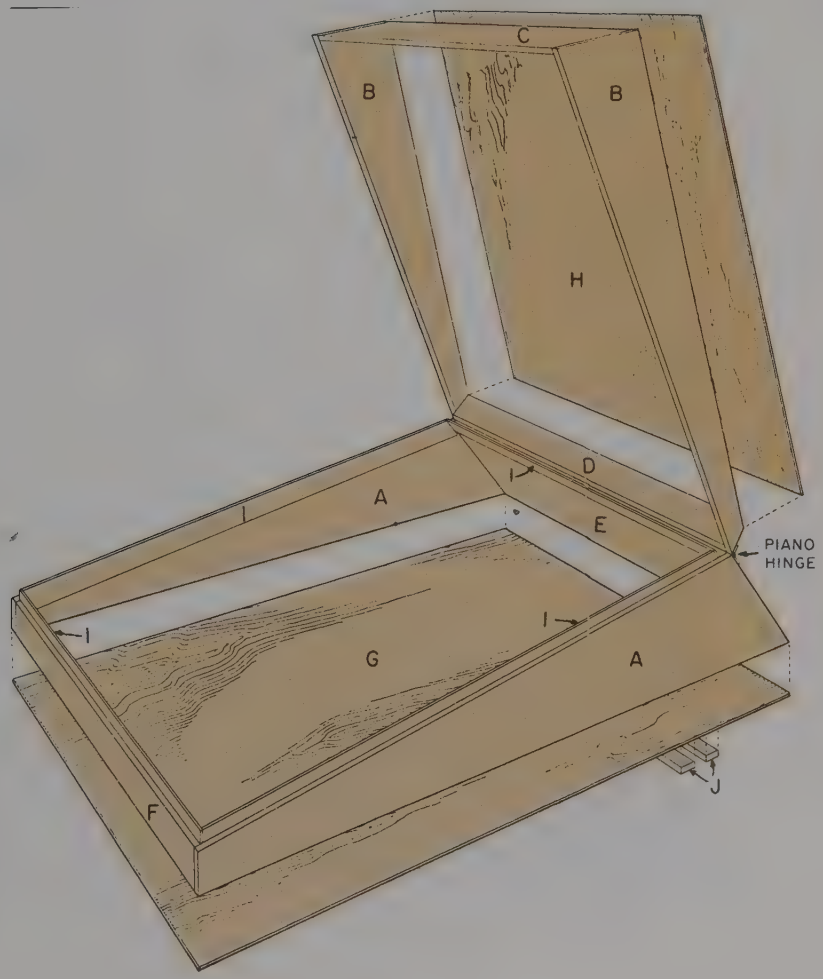
NOTE: Also need, 4d finishing nails, 3d galvanized common nails, waterproof glue, sandpaper, wood filler and paint.

cartridge filters: see filters
cartridges: see reloading

Car Top Luggage Rack



Shown is the cutting diagram with the plywood panel at top of it. The black areas are waste material. Once top, bottom and sides have been cut and attached, check remaining given measurements against them before cutting for perfect accuracy. Size of the luggage rack, can, of course, be varied by altering the dimensions.



Exploded view of the car-top luggage rack. Note that assembly is simple and straightforward entailing merely glue and nails. Cleats at bottom (J) are spaced to fit astride the front carrying rail and prevent forward or backward movement of the luggage rack. Note that parts I project about an inch to provide good seal.

should project approximately 1 inch above the lower sides of the box so as to form a tight seal against weather and dust.

Glue and nail cleats J in place approximately 10 inches back from the front of the box. Space them so that they fit easily over the front carrier rail. They serve to keep the unit from sliding forward or backward.

Install the lightweight stop chains on the lid. Attach the 36-inch piano-type hinge with screws. Sand all edges round and paint.

You may wish to finish your luggage or camp-gear carrier in a striped pattern.

That's all there is to it. You will have a unit that is good for years of service. Construction, as described, is regarded as well within the shop skills of the average camper.

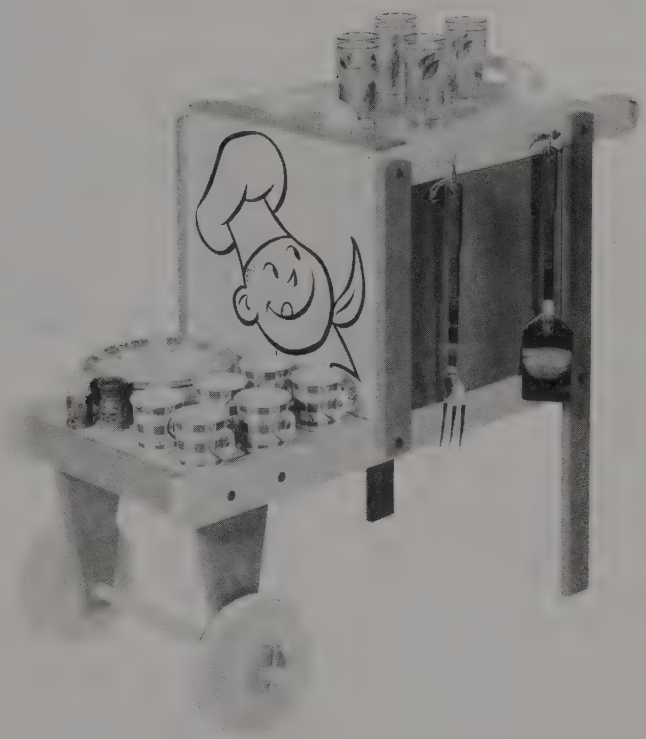
Original design by Steve Ellingson.

See also: POWER TOOLS; HAND TOOLS; PAINTING.

Open and closed views of the unit. Suitcase catches hold lid down and straps at carrier rails secure it to roof of car.

Build a Chef's Cart

Use this barrow to trundle outdoor cooking gear from kitchen to backyard and back



THIS CHEF'S CART was designed to make picnicking on the patio easier for both mother and father. It's used for carting the needed food, dishes, and other supplies from the kitchen to the outdoors. After the meal, it's an easy means of getting everything back into the kitchen again.

The cart has convenient hooks for hanging utensils, plus places for towels, aprons, pot holders, and other accessories. The storage compartment holds other odds and ends, even the bag of charcoal and electric starter coil, with enough space left over for soda bottles, ice bucket, glasses, and even a stirrer. There's even a sitdown section for dad when things get just a bit too much. Anyway, it's certainly all fun, as you can see by looking at the drawing of the junior chef's gleeful smile in anticipation of a great outdoors spread.

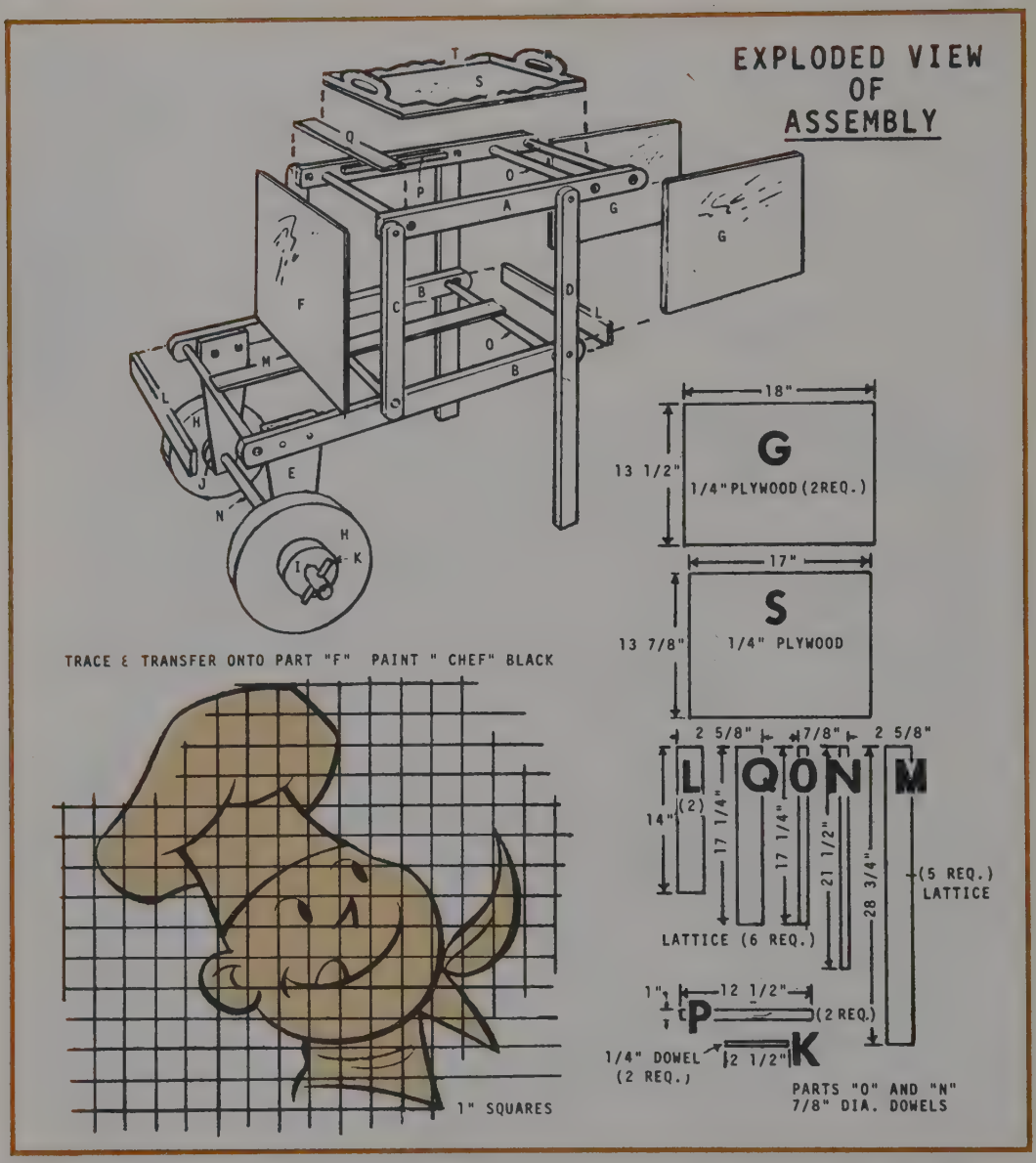
The one sketch contains an "exploded" view of the cart assembly, with each part coded by a letter so that it will be easier to schedule the project and assemble the unit. Each of the parts is shown separately in the sketch, together with the required dimensions. Study both the sectional drawing and the location of that particular part on the exploded view to more easily visualize the assembly before cutting.

Cut out parts A, B, E, H, I, and J. Drill ⅞-inch holes in the places indicated on the sketch. (Note, if you are unable to obtain ⅞-inch dowels, get the 1-inch diameter size, and adjust the directions accordingly, drilling holes of 1 inch to fit.) Drilling positions are shown by large circles.

Drill ¼-inch holes where shown as small circles in parts A, B, C, D, and E. Cut off six pieces, each 17¼ inches long, from the ⅞-inch dowels, and another one, 21½ inches long, for part N. The wheel hubs (part I) are glued and nailed to the wheels (part H).

Assemble the frames A, B, C, D and E with bolts and dowels, but do not apply glue as yet. Insert axle N through the holes in part E, spacers J, and wheels H. Drill ¼-inch holes in the ends of the axle N for ¼-inch dowel pins, K.

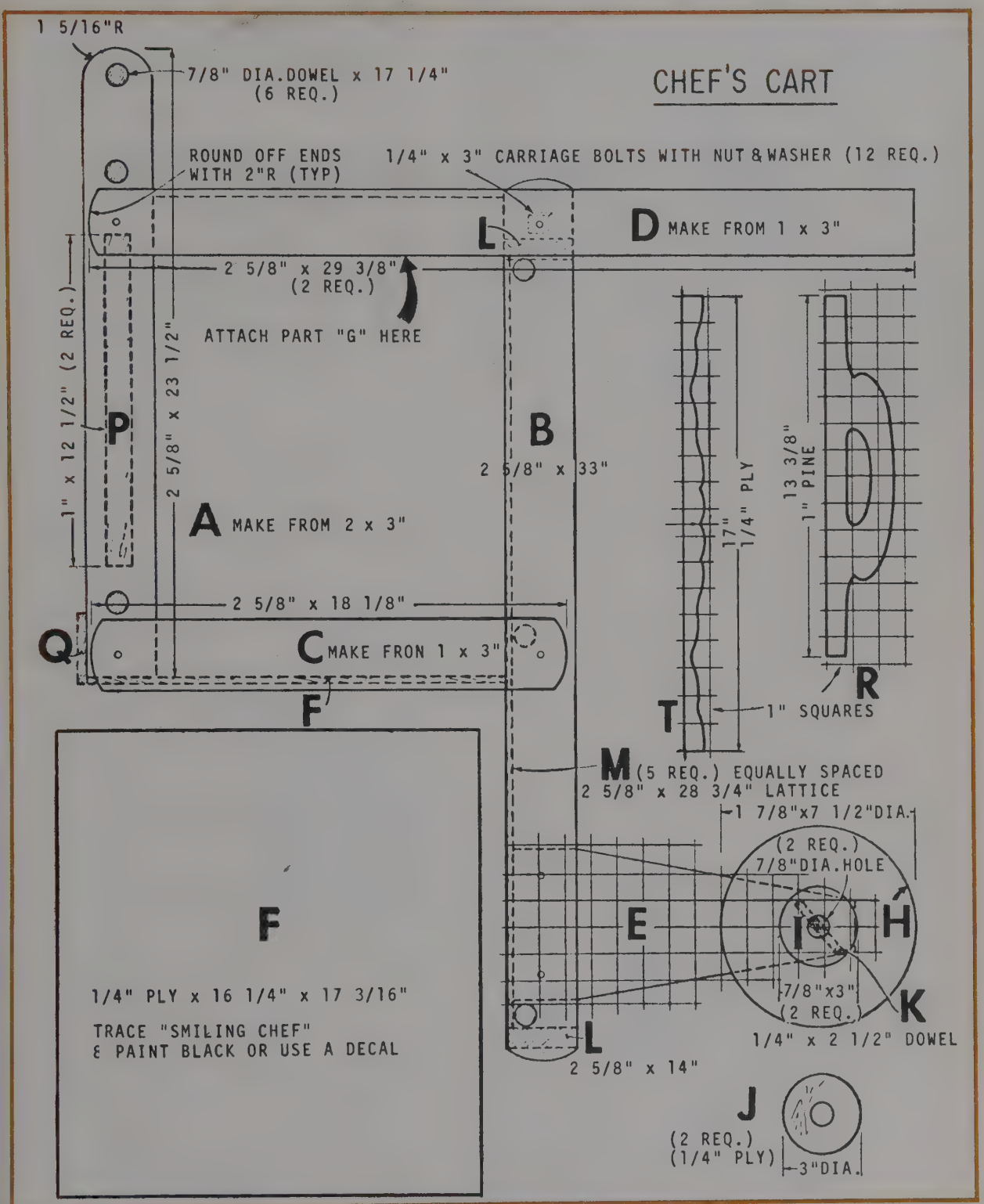
The five M slats are cut to fit, approximately 28¾ inches long, and nailed to the dowels (O). The front and back facing



strips (parts L) are also nailed to dowels (O). Tray support cleats (P) are nailed along the inside surface of the side rails (A).

If all the parts are cut to correct size, but assembled only temporarily, the unit can be taken apart for painting all sides of each part for weather protection, then reassembled with glue when the paint is dry. Finally, make the removable top tray from parts R, S, and T, as shown, and paint the decorative chef's figure on the front in black. Or purchase an attractive and colorful decal from your hardware dealer for the decoration.

In building the cart, a few details will help make it more attractive and functional. For example, round off all exposed edges with a spokeshave or sandpaper, so that there won't be any sharp corners.


CHEF'S CART
1 5/16"R
7/8" DIA.DOWEL x 17 1/4"
(6 REQ.)
ROUND OFF ENDS
WITH 2"R (TYP)
1/4" x 3" CARRIAGE BOLTS WITH NUT & WASHER (12 REQ.)
L
D MAKE FROM 1 x 3"
2 5/8" x 29 3/8"
(2 REQ.)
ATTACH PART "G" HERE
1" x 12 1/2" (2 REQ.)
P
2 5/8" x 23 1/2"
B
2 5/8" x 33"
A MAKE FROM 2 x 3"
2 5/8" x 18 1/8"
Q
C MAKE FRON 1 x 3"
F
T
17"
1/4" PLY
13 3/8"
1" PINE
R
1" SQUARES
M (5 REQ.) EQUALLY SPACED
2 5/8" x 28 3/4" LATTICE
1 7/8"x7 1/2"DIA.
(2 REQ.)
7/8"DIA.HOLE
E
I
H
7/8"x3"
(2 REQ.)
K
1/4" x 2 1/2" DOWEL
L
2 5/8" x 14"
J
(2 REQ.)
(1/4" PLY)
3"DIA.
F
1/4" PLY x 16 1/4" x 17 3/16"
TRACE "SMILING CHEF"
& PAINT BLACK OR USE A DECAL

The cart shown in the illustration was painted deep turquoise and white. The dark and light tones make an interesting color contrast, but you can, of course, select whichever shades will appeal to you or fit your outdoor decorative scheme.

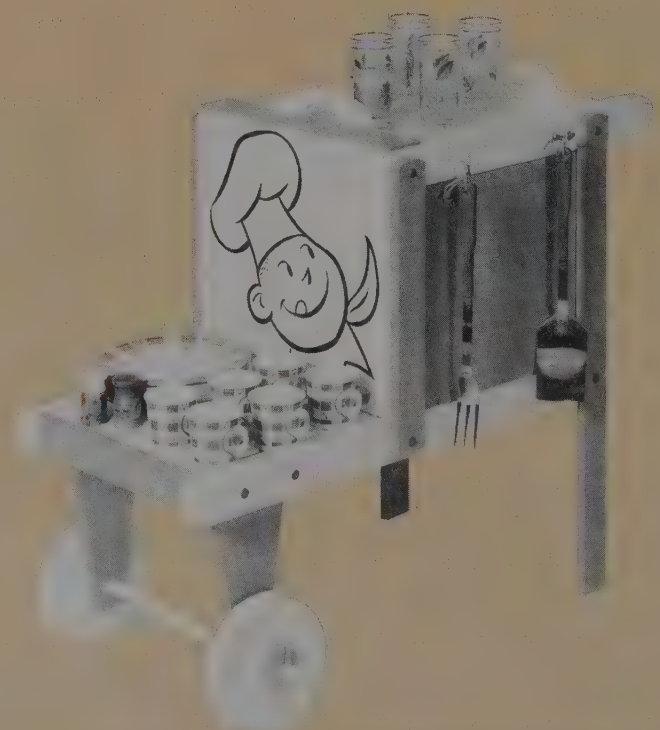
Original design by Steve Ellingson.

See also: FURNITURE, OUTDOOR.

MATERIALS LIST

Quantity	Size and Description	Purpose
1	2″ 3″x6′ clear pine or equivalent.	part B
1	2″ 3″x4′ clear pine or equivalent	part A
1	1″ 3″x10¼′ clear pine or equivalent	parts C, D and L
1	1″ 6″x4¾′ clear pine or equivalent	parts E, I, R and P
1	2″ 8″x16″ clear pine or equivalent	part H
1	¼″ 3′x3′ plywood	parts F, G, J, S and T
1	¼″ 3″x13½′ lattice	parts M and Q
4	7/16″ 36″ dowels	parts N and O
1	¼″ 12″ dowel	part K
12	¼″x3″ carriage bolts	

NOTE: Also need, 2d common nails, glue, sandpaper, finishing lacquer and hooks.



Garden Cart Planter

Enliven any outdoor setting with this three-tiered planter made of exterior grade plywood

ANY PLANT BECOMES MORE INTERESTING when placed in a gay and attractive planter. The floral display shown here will dramatize any outdoor setting, whether on a lawn, patio, or entrance walk. The cart may be wheeled into the sun or shade as necessary to give your flowers the best conditions for flourishing.

The attractive planter is made of exterior grade plywood and will last for many years. It has three stepped-up trays or tiers on which the flowers are planted, making it possible to have several flowers blooming at the same time to provide a variety of colors. The following directions and illustrations will help you build this handsome unit to dress up your outdoor area.

Start by laying out all the parts on the 4x4-foot piece of ½-inch exterior plywood, according to the arrangement shown in the drawing. You will first need patterns for the sides, Part A. Trace the outline on heavy manila paper drawn with 2-inch squares, then back up the manila paper with a second sheet so that you will have two duplicate patterns to fit in place on the plywood. Mark off the dimensions for the other parts—B, C, D and E, plus the planter box sides, ends, and base.

Trace the outlines directly on the plywood for cutting. This can be done most easily with a bayonet or band saw as some of the lines are curved, while others meet at contiguous angles.

Another way would be to cut the shaped "A" sides first from the panel with the bayonet saw, then do the rest on a bench saw as there will be true factory-cut edges on the remaining sections of the panel.

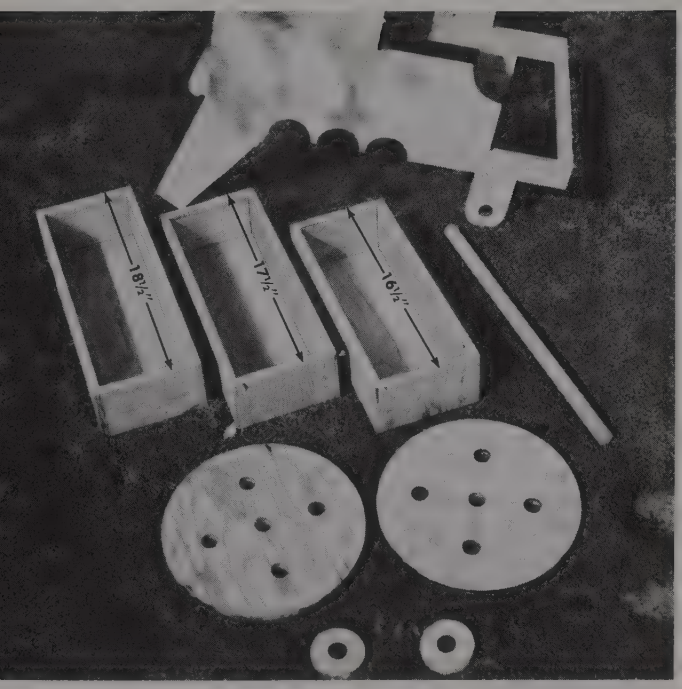
Assemble parts A, B, C, and D to form the cart, as shown in the photograph, using 4d nails and waterproof glue. The base is 17½ inches long, consisting of two pieces each 8¾ inches long.

Two of the planter box sides are 16½ inches long, two are 17½ inches long, and two are 18½ inches long. Shape the two washers for the wheels from ½-inch plywood (part E), each 3 inches in diameter with a 1 inch center hole.

Cut two lengths of the 1-inch dowel, each 15 inches long. One is for the top push handle, the other is for a support between the legs. Attach the dowels with a finishing nail and glue at each drilled hole.

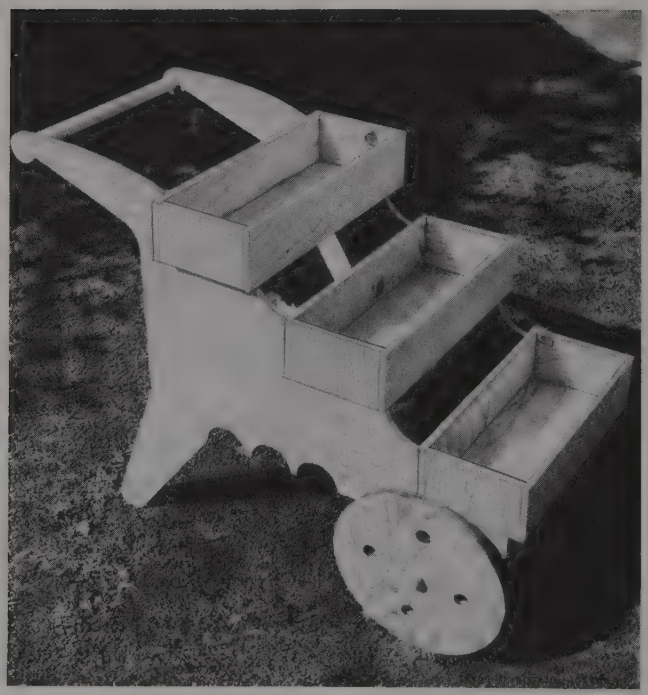
Cut out both wheels from the ¾-inch plywood, drilled for five 1-inch holes, one in the center, and the others evenly spaced around the disc. Make the axle of 1-inch

Garden Cart Planter



All the parts can be cut from a 4x4-ft. panel of ½-in. plywood.

Closeup showing wheels (¾-in. plywood) with dowel axle and wooden inside washer.



Completely assembled cart before painting and applying designs to wheels, sides.

Garden Cart Planter

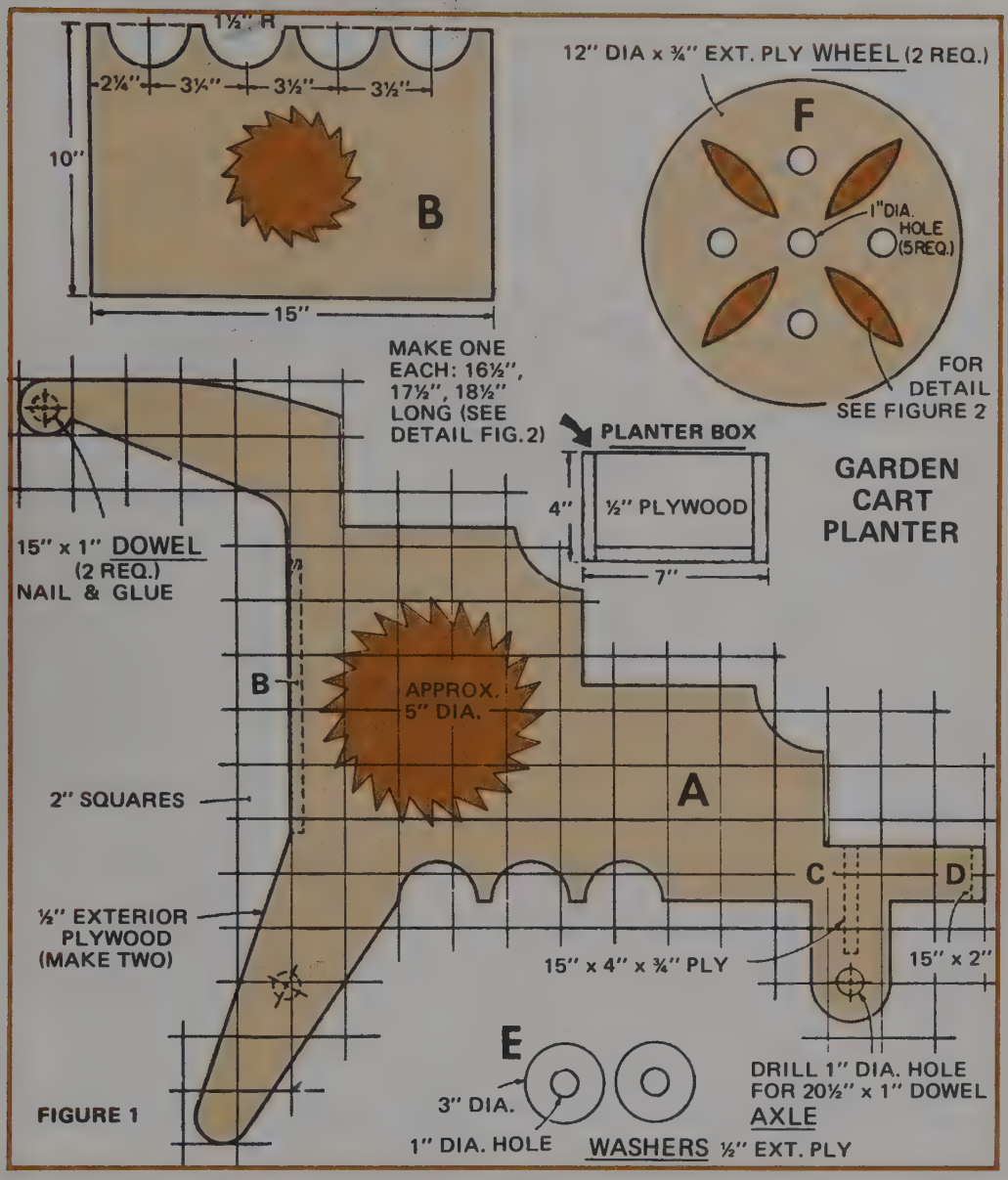


FIGURE 1

MATERIALS LIST

Quantity	Size and Description	Purpose
1	½" 4'x4' exterior grade plywood	basic unit
1	¾" 13"x26" exterior grade plywood	wheels
2	1"x3' hardwood dowel	axles
1	¼"x4" dowel	axle pins

NOTE: Also need, 4d finishing nails, brads, waterproof resin glue and paint.

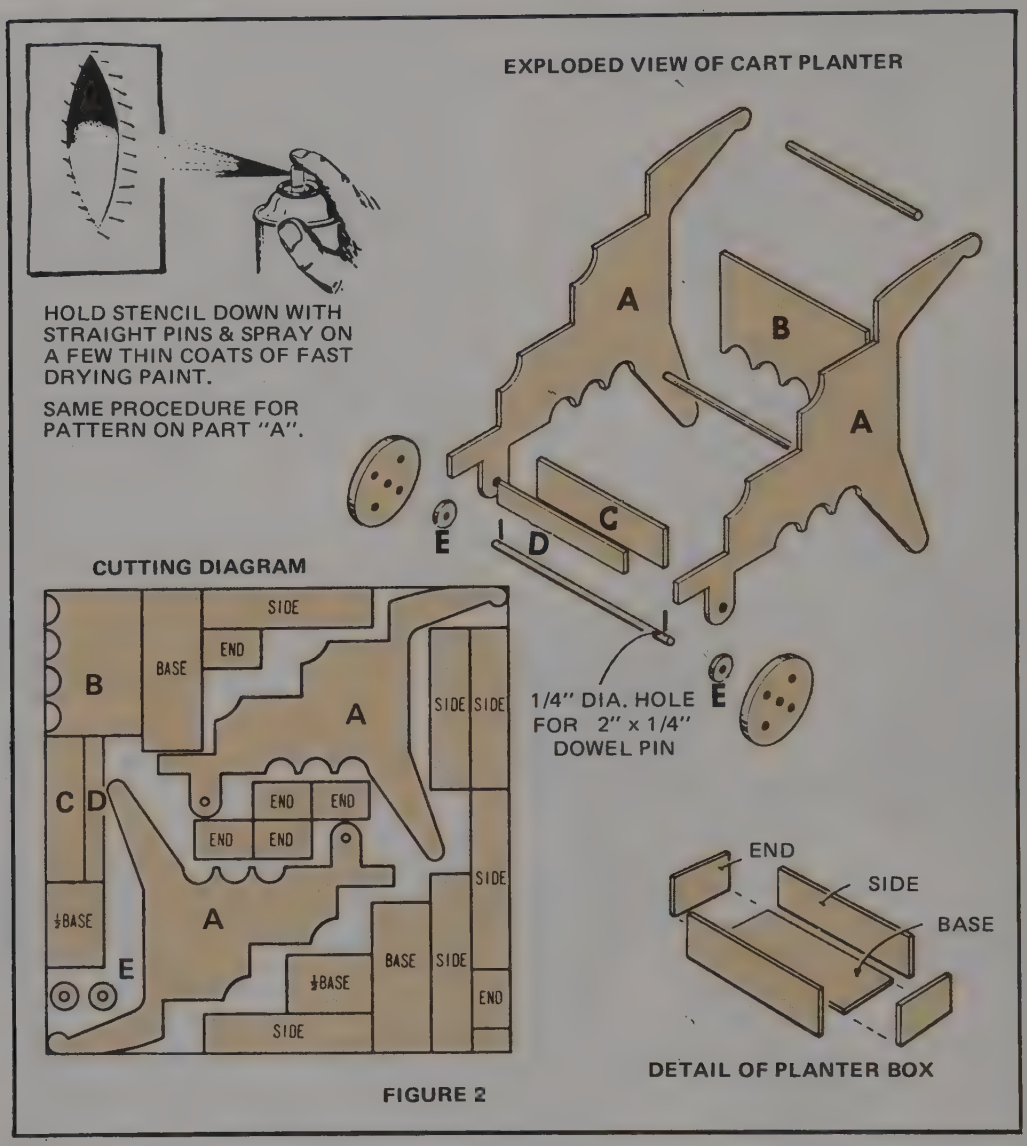


FIGURE 2

dowel, cut to a 20½-inch length. Drill ¼-inch holes in the axle, ¾-inch in from each end, for the 2-inch dowel pins. The washers are placed on the inside of the wheels, and held with small brads.

The sunburst design which is painted on the sides can be traced from a 9- or 10-inch circular saw blade of the ripping type which has large teeth. The neatest way is to trace the outline of the saw blade on heavy manilla paper and cut out the inside part. Then use the rest as a stencil which is held to the plywood with pins while you apply the color from an aerosol spray paint can. Remove the stencil, and the design will be perfect.

Similarly, the spoke design is sprayed on the wheels. Of course, these decorative touches are applied only after the entire cart has been given a protective coat of white outdoor paint.

Original design by Steve Ellingson.

How to Carve Decorations in Wood

You can use these techniques and tools that you make yourself to add a hand-carved touch to your woodworking projects

HAND CARVING on a project made of wood gives it the final touch that marks it as a fine handcrafted piece. It is a creative craft especially adapted to the hobbyist because it can be used to decorate and enhance the value of many homeshop projects already made.

Although the branches of the art vary in difficulty, even the most inexperienced craftsman, when undertaking simple carving, can expect encouraging and creditable results.

Of the bewildering variety of carving chisels available, only a few are needed and these can be purchased, one or two at a time, as required. They range in price from about $2.50 to $4.50 each. Small sets of five or six short-bladed chisels are packaged to sell for as little as $5.00, but they are narrow and are likely to include little-used tools while lacking others more often needed. Fortunately for economy you can make useful carving chisels from old files with a little grinding, an interesting project in itself. Complete instructions for making tools are given at the end of this article.

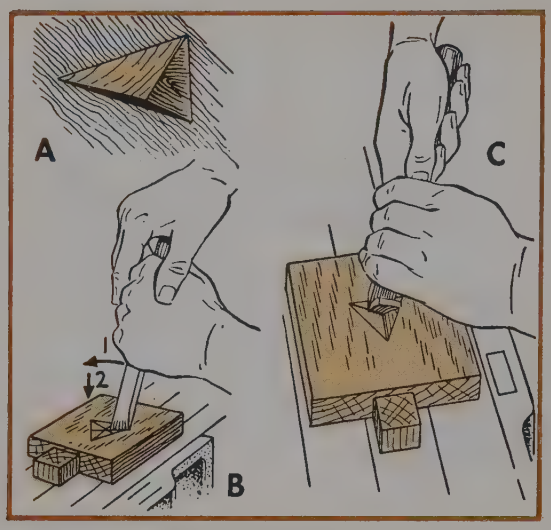
Chip carving is one of the simpler forms of the craft. The essential element, a carved triangular pocket in the wood having three triangular sides, is adaptable in shape and capable of being grouped to make interesting patterns suitable for decorating panels or making borders. The only tool needed is the woodcarver's knife, which is a thin, short-bladed skew chisel.

Almost any firm-grained wood is suitable for chip carving. For practice draw a ½- to ¾-inch equilateral triangle with a pencil on a pine block and bisect the angles. Resting the block on a bench, make three vertical stop cuts by placing the point of the knife at the center of the edge on the point bisectors. Rock the knife toward the point and press down, making the incisions of equal depth by exerting extra pressure when the cut is across the grain.

This done, set the piece against a bench stop and slice in boldly from the edges, removing three pyramidal chips. After some practice the pocket can be excavated with these three cuts, with only a little paring to true it up.

When confidence has been gained with a few practice pockets, a real project, such as the turned powder box, can be undertaken. Lay out the center design directly on the lid by scribing a circle the size of the original diameter of the six-pointed star. Draw a centerline diameter and striking arcs from each end with the original

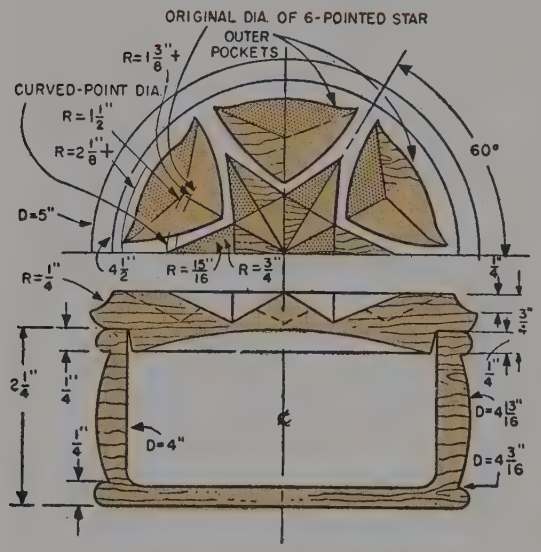
casein glue: see adhesives



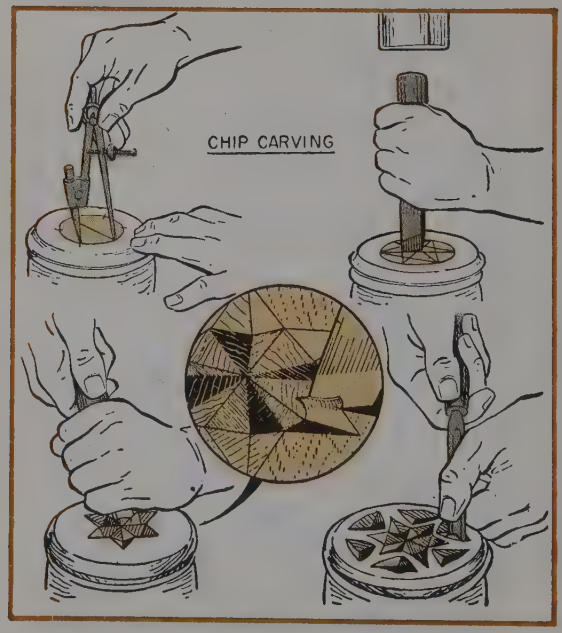
To make a simple chip-carved figure (A) draw an equilateral triangle on a pine block and bisect the angles. Make three vertical stop cuts. Place the knife on a bisecting line with the point on the center of the triangle (B) and press while rocking the knife toward the point. Then use three bold slices to form the edges, removing a triangular chip each time.

radius. Draw the sides of the star points from these intersections. The stop cuts in the firm walnut are made to depth with a mallet. As the pockets are lozenge-shaped four stop cuts are needed for each, and four slicing cuts from the edges in a direction to work with the grain.

Interest is added to the design by curving the sides of the points to extend them slightly. This is done with paring cuts of the knife, beginning at the point on one side and working toward it on the other, to cut with the grain. Outer pockets with curved sides are carved between the points. A curved knife, with the edge curved well back, is needed here; or the sides of the pockets can be cut with a gouge having a curvature, or sweep, as nearly equal to that of the side as possible.



To execute the carved powder box lid, first lay out the design starting by scribing a circle of the star. Use the same radius to mark the points. A mallet will help in making the stop cuts in the hard walnut. Use paring cuts to shape the star. Curved outer pockets are cut with a gouge of approximately the same curvature as the work, or use a curved knife.



Incised carving, having the design sunk below the surface, has the virtue of durability, since the background is raised, presenting broad, flat surfaces with no raised points that are subject to wear. The simplest kind, or at least the easiest to execute, is the forming of designs with simple gouge cuts, as in the book end. Two cuts per pocket are needed, a relatively vertical stop cut and another slicing one sloped to meet it at the bottom.

This second cut, in hard wood, may require one or two mallet taps. The design can be varied by lengthening the slicing cut to form short flutes, which may have stop cuts at both ends or a slicing cut at each end, in which case a stop cut is made at the center.

A second form of incised carving, known as "scratch" carving, is simply an outline drawing made with a narrow gouge or a vee chisel, 1/10- to 1/8-inch wide. Scratch carving appears in the book end in the circle and borderlines. The gouge is the easier to handle, as it can be twisted as it moves forward, giving a shearing cut. Center the cut on the guide line, and as far as possible, work with the grain.

In shallow cuts the vee chisel, or parting tool, can be steered quite easily, regardless of the grain on the wood. In deeper cuts trouble is likely to to be encountered, as one side of the tool cuts with the grain, the other against it. The remedy is to make a stop cut down the center of the proposed groove with the tip of the carving knife. This done, slice with the grain by inclining that side of the chisel toward the side to be cut. Cut the other side from the opposite direction, again with the grain. This is a useful procedure when carving circles.

Low relief carving consists of cutting away the background of the work to a depth of 1/16- to 1/8-inch, leaving a flat ornament projecting. The effect is similar to the imitation variety in which the design is jigsawed and glued onto the ground; but there is this difference, that the grain of the ornament and the background is continuous, instead of broken, and the edges may be made to melt into the background, instead of meeting it at a distinct angle. Colonial furniture decorated with low relief carving was sometimes painted in contrasting colors to heighten the effect of relief.

Using a knife with a curved edge to carve the outer pockets of the powder box lid.

On the book end, a tree-like form contrasts with a stippled background. If a variety of gouges is available, outline the relief with stop cuts which can be inclined to buttress the raised parts. As far as possible select gouges with sweeps to match the curves. For this type of ornament it is often possible to limit the curves to two or three radii corresponding to the gouges at hand. It is best to keep the stop cuts of equal depth. This can be done to an extent by counting the taps of the mallet, taking into account that wide chisels require more force than narrow ones. Bits of masking tape stuck on the blades will serve as depth gauges.

Outlining can also be done with a 1/8-inch gouge. Start cutting with the tool outside the guide line, pushing the handle with the right hand and guiding with the left. Give the gouge a semi-rotary motion to

shear across the grain. The cuts are made with the side of the gouge grazing the line, working with the grain. Rough down the background with a gouge and plane flat with a firmer chisel held bevel-down. To get depth it may be necessary to go around the design a second time with the small gouge. The method limits the number of chisels required.

The ground may be left as formed by the firmer chisel, or further textured with cuts of the narrow gouge along the grain, or with grooves with and across the grain. Stippling is popular and usually the carver makes his own stamp by squaring the end of a thick nail and filing crossing grooves with a three-square file. Holding the stamp between the thumb and forefinger, tap lightly with a hammer, moving it evenly around. Avoid the tendency toward heavy blows that break wood fibers loose on the ground.

Time and labor can be saved by routing the background on a drill press. This still leaves the trimming of the relief edges to do with chisels, and the ground, if left unstamped, is improved by chiseling it over to restore the handcarved appearance. Such relatively primitive carving is enhanced by ornamenting the plain raised surfaces with chisel cuts or scratch carving.

Strapwork is a logical development of low relief carving, usually executed as interlacing, slightly hollowed bands. There are many traditional designs that are fitted to use on furniture built in the home shop. A good treatment is a repeating pattern of intertwined ribbons separated by plain panels, as in the picture frame and design. The layout must take into account the dimensions of the area to be filled. Almost always the design is bisymmetric.

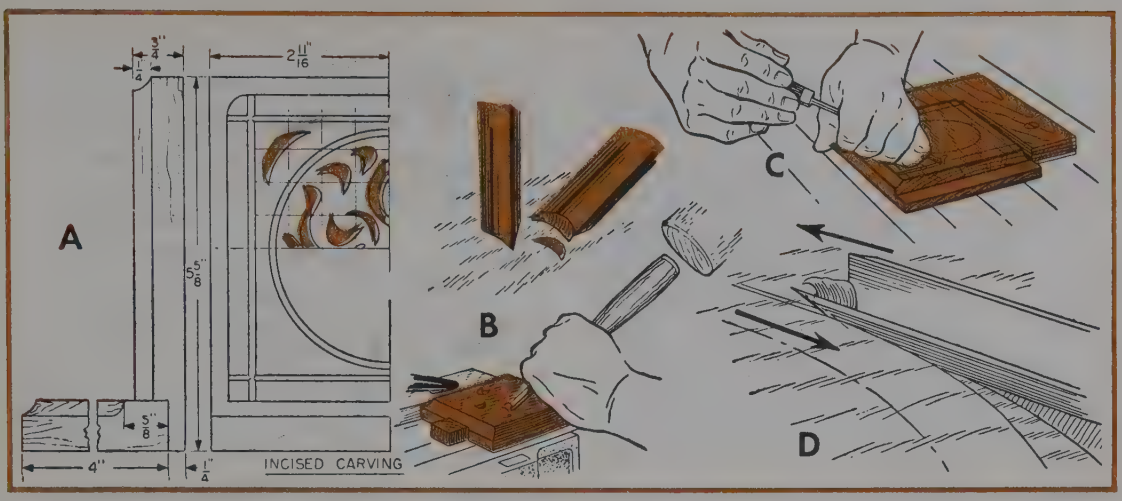
Having traced the design on the wood, prick the circle centers and draw them on the work with a compass. As a first step in carving, select a gouge of a slightly flatter sweep than the little center bosses, which are called "pearls," and make stop cuts around them. Rough-in a pearl by trimming around it with the grain, using a gouge with the bevel side out. Round off further with paring cuts from the top. The finished dome or pearls should be semispherical.

Next rout the background, leaving the ribbon design in relief. The effect of interlacing ribbons is obtained by making stop cuts along the edges of the upper strands followed by trimming down under ribbons to slope them toward the bottoms of the stop cuts. The bands may be ornamented with a fine vee cut along the center, by crowning them, or by hollowing with a narrow gouge. Using the ⅛-inch gouge cut a center trough which serves as a stop cut. Trim each side separately with a gouge, cutting with the grain.

The general feeling among artistic wood carvers is that the work should be left with the tool marks showing. If filing or sanding is resorted to take care not to blunt or round arrises nor to degrade the veining. There is some reason to sand moldings, and with certain designs the interest could be enhanced by filing and sanding certain units in a repeat design, leaving the remainder as the tools produced it.

It seems inevitable that a small chip or even a good-size block will be broken out from time to time. Larger pieces can be saved in a can until the carving is done, and then glued in place; but tiny chips should be dealt with as they appear. A drop of white plastic glue on the chip, with the excess rubbed off when the bit is pressed into place with the fingers, secures the chip and prevents its being lost. After the glue is dry, work over the patch with a chisel to clean off the glue and bring the surface down.

The finishing of carvings is something of a problem. Rubbing with linseed oil, although practiced by the old-timers, gives little protection to the wood and is hardly



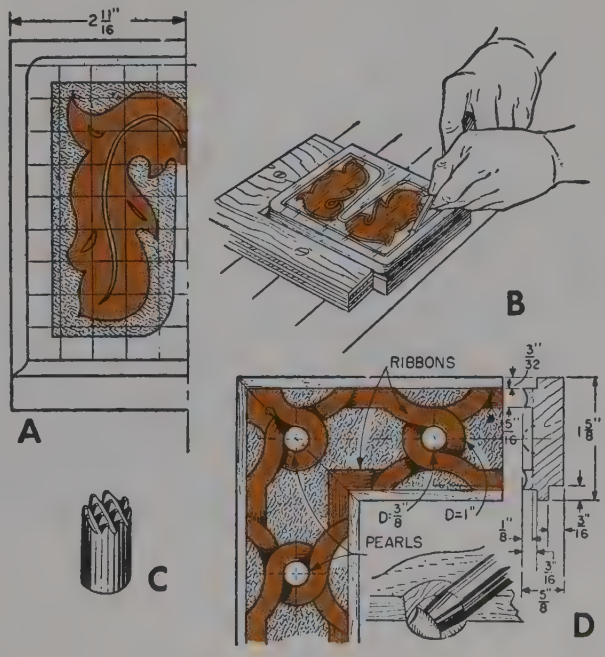
adequate, yet a glossy finish is to be avoided. One or two coats of thin shellac followed by waxing is sometimes recommended. Two coats of a modern lacquer-type brushing finish leaves a surface with a soft glow that is both pleasing and protective.

Making and sharpening carving chisels. Discarded files are made of excellent steel and can be fashioned into flat and gouge chisels with comparatively little labor. Even if files must be purchased for certain shapes a good saving in cost is realized over buying ready-made curving tools. The transformation of a flat file into a firmer chisel is done by cutting off the point of the tang, grinding the tang shoulders square, and nicking each side about halfway up. Clamp in a vise with the nicks even with the tops of the jaws, grasp the end of the file with the left hand, and break it off with a light hammer blow. Grind a long bevel having an included angle of 10-20° on one side, being careful not to draw the temper. Dip file in water as you guide it to keep it cool. Grind off enough of the file teeth to brighten the blade 2 inches back from the end to observe color changes when tempering. The blade will be more of carving style if ground tapering back a little from the cutting edge.

While a tool made from a file will take a sharp edge, it is too hard and brittle and the

The quarter-moon shaped figures in this bookend (A) are formed with two cuts of a gouge, a relatively vertical stop cut and a slanting cut that meets it (B). Circles or other straight or curved lines can be cut with a V-chisel (C and D) if they are relatively shallow. For deeper work, especially when one side of the tool is cutting with the grain and other against it, cut a stop cut down the center of the incision and cut each side separately.

To carve a relief form such as a leaf (A), outline it with a series of stop cuts made with gouges whose curvature corresponds to shape of the work. If the few gouges are available, use a small gouge to outline the shape as in incising. Use a gouge to rough out the ground (B) then plane it flat with a firmer chisel held bevel down. The background can be stippled with a tool (C) made of a thick nail with a pointed design filed in its end. In the strap work project (D) the first step is to carve pearls with a gouge.



edge is likely to break.Therefore it is better to draw the temper somewhat. Holding it with pliers at the tang, hold it in the flame of a blow torch or even a range burner, letting the edge project beyond the flame about 1-inch. As the blade heats a range of colors flows over it, beginning with a light yellow that quickly changes to dark, then to brown, and off into blue or purple, which is a good deal too soft. Try to catch the color as it changes from the light "straw" to dark, and then immediately plunge the blade vertically into the center of a jar of water. Quenched at this color the edge can barely be touched with a good file. If filing is easy or even merely difficult, the steel is too soft and will become dull quickly.

In the event the tool is too soft, heat red hot and again plunge into water vertical and in the center of the container to prevent warping. Then polish the surface with an emery cloth and try tempering again.

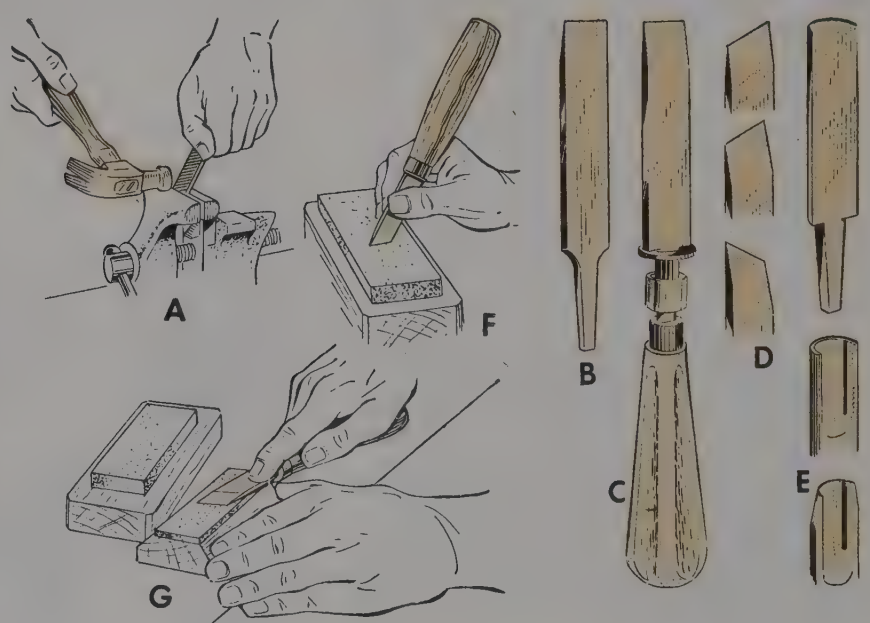
Tapered from both sides the blade becomes a carving chisel, and angled off about 30° a skew. A firmer chisel so sharpened is a left or right.

Turn tool handles from hardwood, fit the ends with ferrules sawed from a piece of tubing, such as ½-inch electrical conduit. Slip a plate washer over the tang first as a thrust washer. Gouges are made in much the same way from half-round files. Cabinet files are flatter in curvature than wood files, but the sweeps can be regulated by grinding. Square the end, grind a bevel, and rough out the inside on the corner of the grinding wheel. True up with a round-face grinding wheel 1¼-inch in diameter or less mounted in a drill press or lathe. It is only necessary to hollow the blade for about 1-inch.

Straighten edges by holding the tool in a vertical position and rubbing on an oilstone. Whet sharp on an oilstone, preferably finishing with a hard Arkansas stone, afterward stropping on a strip of leather glued to a block of wood and rubbed with a bar of Tripoli polishing compound. A vee chisel (parting tool) should be purchased when needed. A set of three or four carving slip stones is desirable, especially for removing the burr inside gouges and parting tools.

M.E.

See also: FURNITURE, INDOOR; WOODWORKING.



➤ *Make carving chisels out of discarded files. In some shapes, it even pays to buy files and make your own tools rather than buy them. To trim the file to suitable length, notch each side where you want the break to fall, then clamp the file in the vise (A) with the nicks flush with the tops of the jaws and hit it with a hammer. Grind the blade to form a carving chisel (B), skew (D) or gouge (E). Use a ferrule and thrust washer (C) when mounting chisel in handle. True edge, as in F, and sharpen (G) using an Arkansas stone.*

How to Make High Relief Carvings

Develop your skill with these projects, then go on to decorating furniture with your own designs or with designs adapted from photographs and museum pieces

HIGH RELIEF CARVING is a logical development of strap carving. This type of deep carving is used not only to model leaves and floral forms, but also animals, human figures, grotesque creations, and even abstractions. While naturalism is acceptable in certain designs it must be restrained and simplified, or it becomes an exercise of the carver's skill rather than a work of art. In general, ornamental carvings should occupy only a minor area of the surface of a large piece of furniture—about one-third or two-fifths. More than this is likely to be too much. However, some excellent museum cabinets have been carved all over, but these cannot be considered as furniture pieces for homes of today.

When designing carved panels, let the carving follow the structural lines of the piece and keep carved details flush with the surface, rather than bulging beyond it. Avoid undercutting. Few extra tools, in addition to those used for low relief carving, are needed. Fine work can be accomplished with a few chisels. Two useful skew chisels, right and left bent, are invaluable at times for carving backgrounds in small areas. The offsets of the tools clear the raised parts of the carvings that would otherwise interfere if flat chisels were used. These chisels can be made of flat files by heating the metal to draw the temper and bending in the offsets. Reheat to a cherry red and plunge vertically into water to harden, polish bright spots at the ends, and heat again to temper, quenching when steel turns to a dark straw color.

Carving motifs, of course, are endless in number and the carving of only two or three practice pieces will give you the skill and confidence needed to incorporate high relief carving on your furniture projects. Original designs can be created, patterns from other crafts adapted, and museum carvings copied.

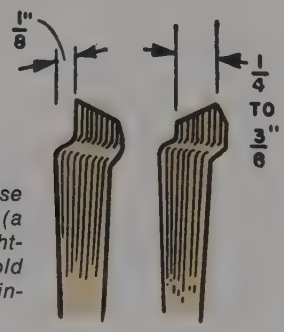
The most used of all carving motifs is the acanthus leaf, which has appeared in architecture and furniture in innumerable forms. This simple version can be adapted for use as a single ornament on a box or book end, or in multiple to compose borders, or to encircle a turning. For practice, lay out the design on a pine block, drawing the curved

upper end with a compass. Be sure your chisels are razor-sharp—both for clean cuts and for safety.

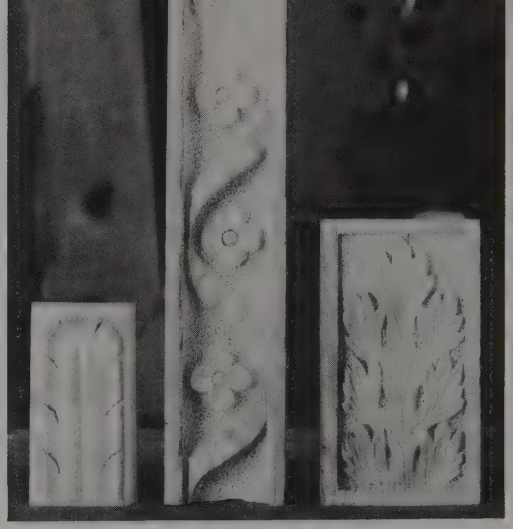
Since the relief is slight, outline the leaf with a ⅛-inch gouge, using the semi-rotary twisting of the chisel as it is pushed forward. Lower the background with a skew chisel, rounding off the arrises and rolling the upper corners to give a semielliptical profile to the top end. Cut in the center vein with a vee chisel.

Carve the hollow areas of the leaf with a gouge after making a tentative cut to discover the direction of the grain. Ease the cut around the curved end, rocking the tool a little to increase the shearing action. Working across the grain the chips will crumble out. Smooth with light paring cuts of a flat gouge, moving along the grain. Shape the beaded center part of the leaf with a skew chisel, sweeping the rise around the end of the center vein. The contour of the leaf is now complete. Cut the serrations with a gouge, making center stop cuts with the gouge held vertical and driven lightly with the mallet. Trim the sides with rocking motions to shear off the crushed edges. Do final trimming with a skew chisel.

For the more elaborate form of the acanthus leaf, draw ½-inch squares on paper and make a full-size sketch of the half-pattern and outline of leaf on left side of the centerline. Then transfer the simple outline at the left with carbon paper to a blank of wood having no prominent grain to deflect the chisels on small details. Incise



You can make these bent skew chisels (a left-hand and a right-hand version) out of old files. See text for instructions.



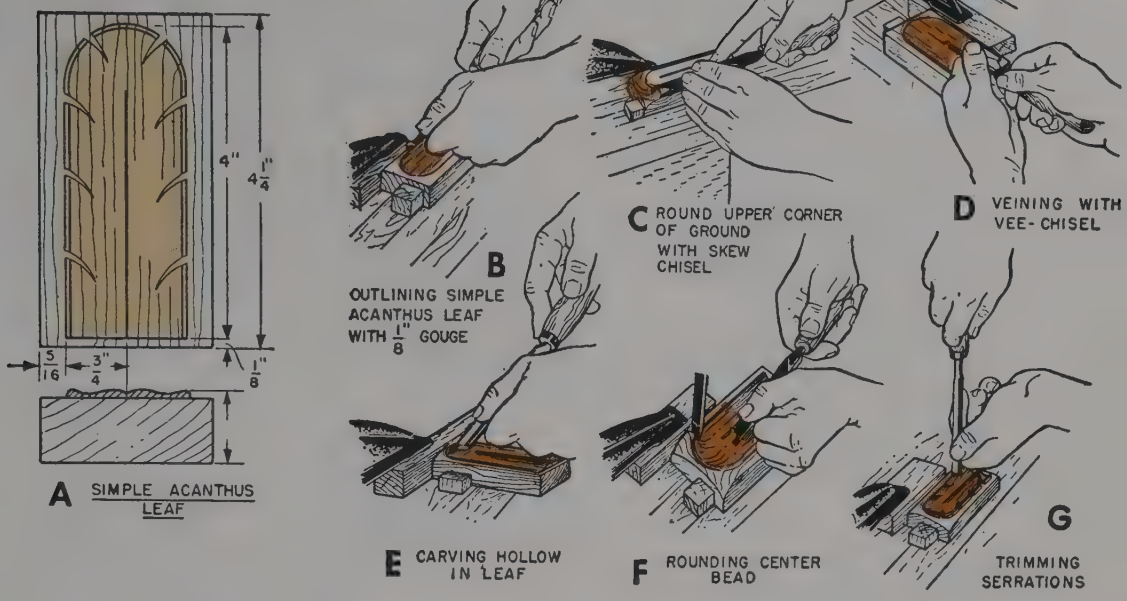
Three relief carving projects are, left to right, simplified acanthus leaf, flower and ribbon molding, and fully carved acanthus leaf.

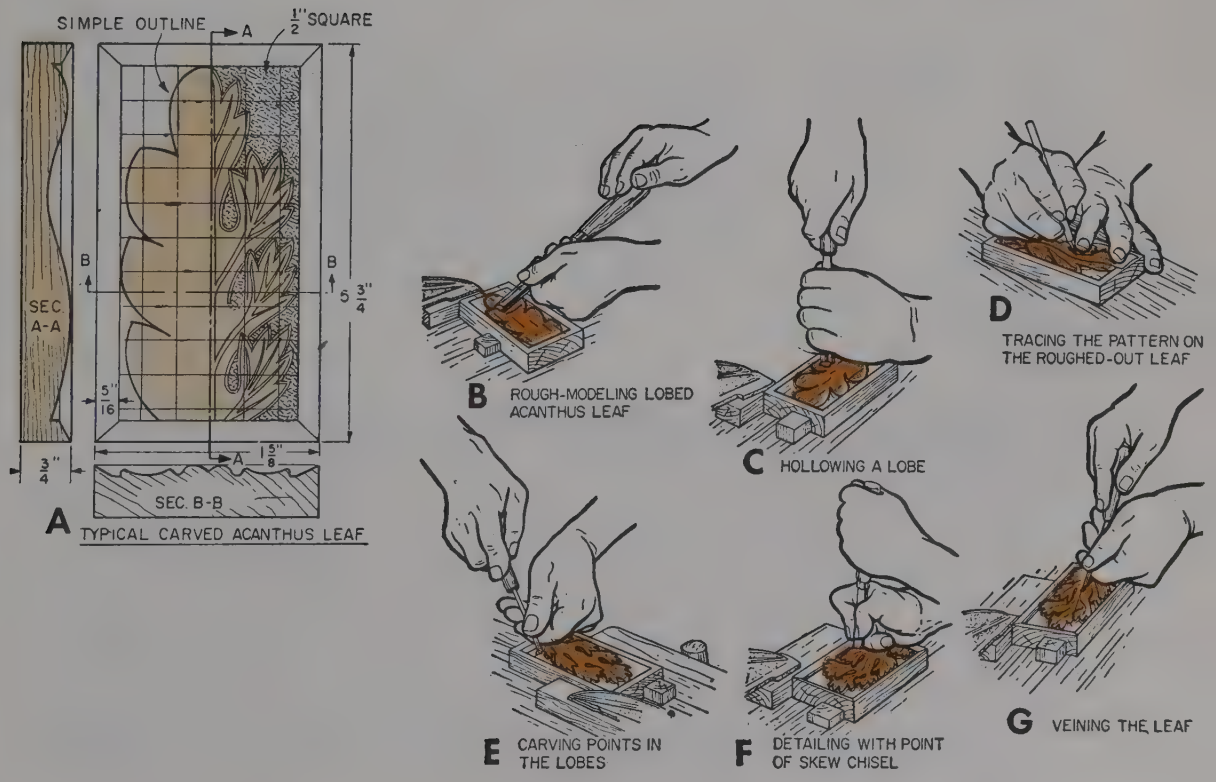
the outline with deep stop cuts, using gouges of suitable sweeps. Now rough out the wavy lengthwise profile with cross cuts of a gouge, leaving stock for the higher center part. Good control is obtained by using light blows of the palm of the hand against the chisel handle. Further model the leaf lobes by hollowing them lengthwise with a gouge. Note that one point of each lobed section laps over the lobe above.

After the leaf is roughly modeled, sketch in the details of the edges, or bend the pattern to fit the profile, centering a leaf section on its lobe. Trace the details and enlarge slightly to fill the space. Carve the points and dig out the background with the ⅛-inch gouge, turning to a skew chisel.

Vein the leaf by sketching in the guide lines and using the vee chisel. Using these as stop cuts, hollow the points individually with a small gouge, then deepen the veins to their proper values. Cleaning up the background is made easier if the border is beveled, a treatment that blends well with the design. Work it down with the heel of a skew chisel, carefully finishing the miters at the corners. Stipple the ground with a large nail cut off square and filed with four grooves, two crossing the others at right angles to make pyramidal points.

Moldings are carved with all manner of


4"
4 1/4"
5/16
3/4"
1/8"
A SIMPLE ACANTHUS LEAF
B
OUTLINING SIMPLE ACANTHUS LEAF WITH 1/8" GOUGE
C ROUND UPPER CORNER OF GROUND WITH SKEW CHISEL
D VEINING WITH VEE-CHISEL
E CARVING HOLLOW IN LEAF
F ROUNDING CENTER BEAD
G
TRIMMING SERRATIONS


SIMPLE OUTLINE
A
1/2" SQUARE
B
B
5 3/4"
SEC. A-A
5/16
3/4"
A
1 5/8"
A
SEC. B-B
A TYPICAL CARVED ACANTHUS LEAF
B ROUGH-MODELING LOBED ACANTHUS LEAF
C HOLLOWING A LOBE
D
TRACING THE PATTERN ON THE ROUGHED-OUT LEAF
E CARVING POINTS IN THE LOBES
F DETAILING WITH POINT OF SKEW CHISEL
G VEINING THE LEAF

ornament. One of the most distinctive designs is a coiled ribbon in the hollow or cove of the strip. In this example, the molding, consisting of a rounded center bead flanked by flat borders ¼-inch wide, is made by hand or machine. Make a ribbon pattern by sketching one section on a strip of paper wide enough to reach from border to border when bent around the arched portion. Keep the helical character of the band by curling it strongly at the edges, making the center almost straight. Note that the ribbon rolls upon itself as it reverses direction. First outline the bulging outer sections of ribbon by stop-cutting along the edges. Then hollow the background to within ¼-inch of the depth. Turn the pattern over and trace the ribbon on this ground, or sketch it in. Block in the blossoms with a compass and outline both them and the under ribbon with stop cuts and by running the ⅛-inch gouge around. Carefully finish hollowing the ground, rolling it nearly to the vertical at the edges to give an elliptical character. Then dress down the inner ribbon to project a little under ⅛-inch. Stop-cut around the centers of the flowers with a gouge, carve them into hemispherical "pearls" and form the petals, fitting them into the curve of the ground. Hollow the petals and chamfer the edges.

The final touch on the ribbon is to shape it into little waves and folds by cutting hollows of various depths with chisels of different sweeps. These grooves can be relatively parallel, or may vary in angle and taper in depth. Round the folds smoothly to avoid the appearance of kinks. Leave the outside turns of the ribbon full thickness to the base. After final trimming, chamfer the edges of the ribbon, and stipple the ground.

Pierced carving is useful for screens and door panels where openings are desirable for ventilation, or for plaques, and whatnots. To make the whatnot, first draw the pattern and trace onto the side pieces. Groove the sides to house the shelf ends, rabbet the backs, and tack the two sides together for scroll-sawing at the same time. This operation saves much of the "firming-in" or outlining, reducing it to crossings of stems, etc.

Pierced work is necessarily fragile and clamping down is difficult, especially when one side is already carved. The bench stop with a strip of wood clamped alongside the work will keep it from sliding under chisel pressure. Use a mallet cautiously.

Carve the leaves hollow on the outside, with veins incised with the vee chisel; on the inside faces they are convex, with the veins standing out. Crossings of stems and tendrils complement each other; stems crossing over on one side cross under on the other. Outside berries are in groups of three, the innermost connecting with stems, while on the inside there is a fourth berry on top of the three to which a stem attaches.

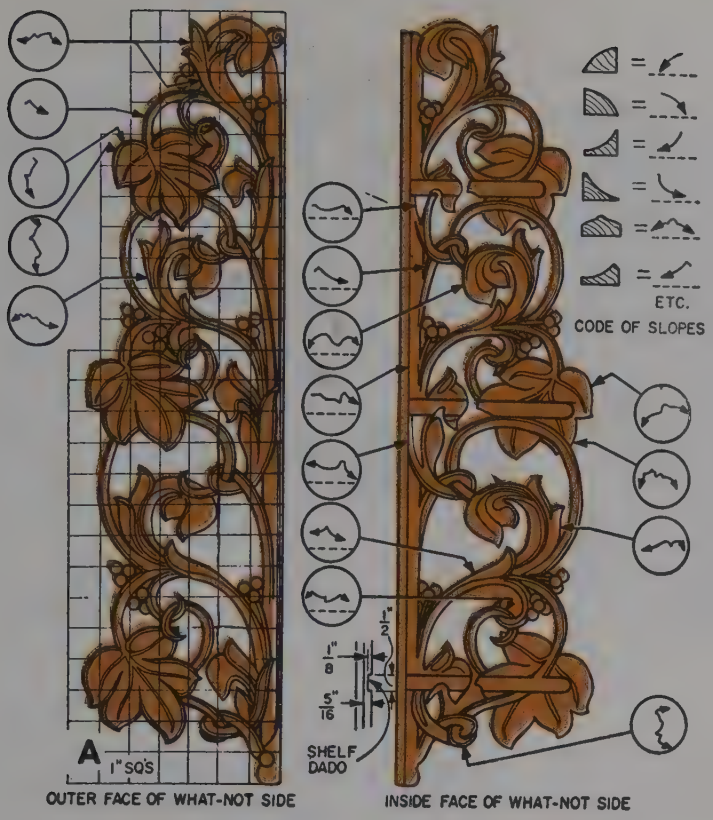
Assemble the whatnot with glue, using

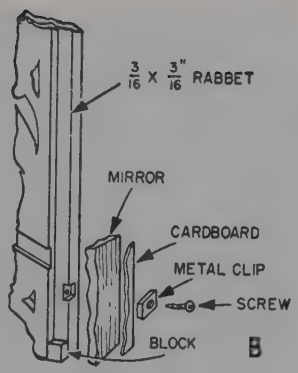
MATERIALS LIST

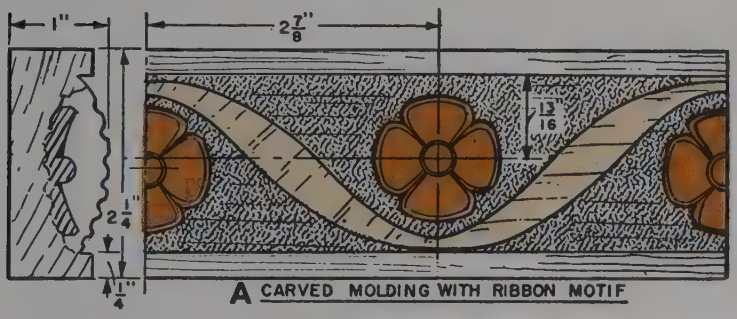
Quantity	Size and Description	Purpose
2	½" 6½"x25" Cuban mahogany	sides
1	½" 4½"x18" Cuban mahogany	shelf
1	½" 5½"x18" Cuban mahogany	shelf
1	½" 5⅝"x18" Cuban mahogany	shelf
1	3/16" 18"x26" mirror	
6	1/16" ⅜"x⅝" metal clips	
6	#2 ⅝" flat head screws	

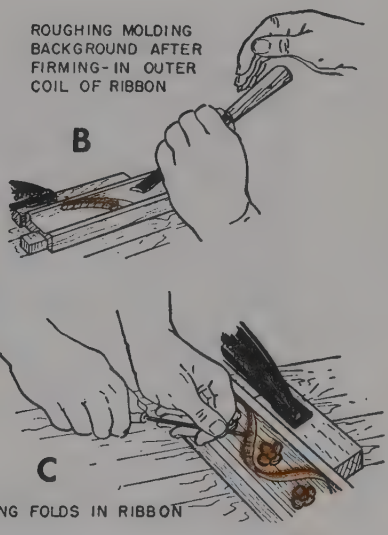
NOTE: Also need, stiff cardboard, glue, contact cement and finishing coat.

PLANS: Craftprint, 229 Park Ave. So., New York, N.Y.









blocks with cloth pads between them and the carving to avoid clamp mars. Square assembly before glue dries, and finish.

Shelves will be occupied by novelties so use an ordinary mirror with top and bottom edges ground smoothly. Back mirror with stiff cardboard. Coat edges and the rabbet with contact cement just before entering the glass. Drill pilot holes for the clip screws in the back edges where the screws will pass the glass without touching. A block glued into the lower end of each rabbet keeps mirror from sliding out.

To lay out turned work for carving, wrap a strip of paper around it and mark the point of lap, measuring the circumference. Divide into the required number of spaces and trace the motif units in each. Wrap this pattern around the turning and trace the design onto it. Clamp the work in vee blocks or, if the work piece is large, support it in a sawbuck. M.E.

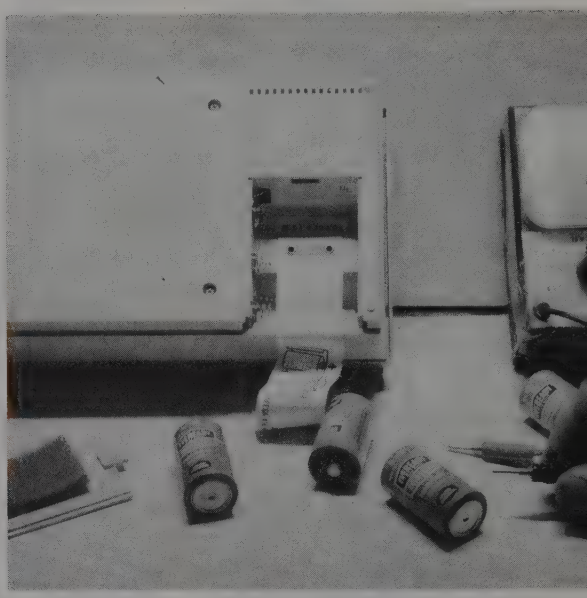
See also: ANTIQUING; CHISELS; FURNITURE, INDOOR; HAND TOOLS; INLAY WOODWORKING.

Ten Steps to Cassette Player Repair

Trouble-shooting your cassette player will give you extra hours of enjoyment

CASSETTE RECORDERS come in every size and shape. They play on dry cells, AC line or operate right in the car. Generally, the portables are monophonic while table and console models are stereophonic. New cassette decks may feature "pop-up" cassette loading, level meter, remote control mike, push-button controls, tag-along speakers, and AC bias erasing system, to name only a few. After many hours of rough handling these cassette units will require servicing. This 10-step approach to trouble-shooting will give you an edge in cassette repair. H.L.D.

See also: ELECTRONICS; TAPE RECORDERS.

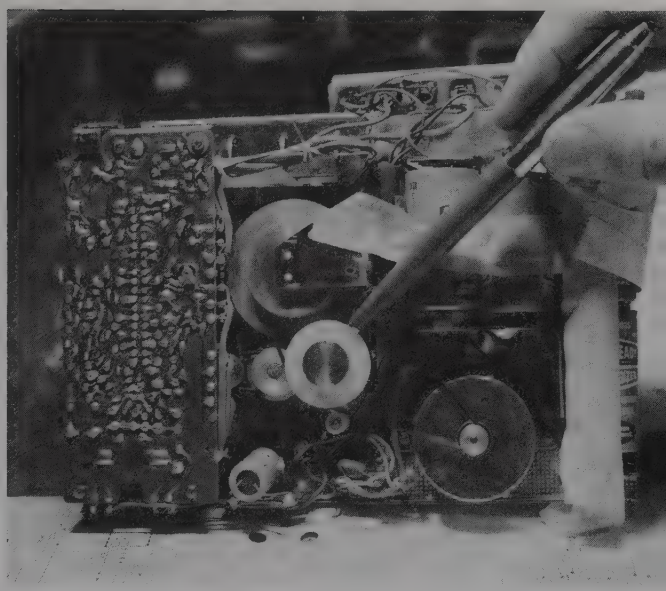


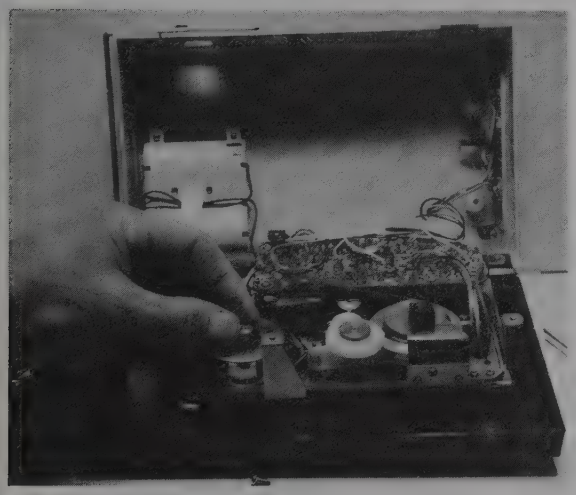
▲ *In case the recorder will not play, check the batteries. Check for corroded battery terminals or broken wires. Clean battery terminals with a knife or emery board. Disconnect one battery wire and insert VOM switched to low milliameter scale. No current indicates a defective on/off switch, bad battery connections or dead batteries. Excessive current indicates a short in motor or amp circuit. If unit works on batteries and not on AC suspect trouble in the power supply. A step-down transformer and rectifier produces this DC. Check AC voltage at rectifier and DC voltage at motor.*

➤ *Low volume and background noise caused by a dirty tape head. Excessive oxide dust will accumulate and pack upon the tape head. Tape heads should be cleaned every sixty days to keep them in tip-top condition. Clean head with tape-head cleaner or just plain alcohol. Use a cotton swab, dip in alcohol and remove the oxide dust. A special tape head cleaning cassette can also be inserted in place of the cassette. Don't forget to clean around and under the tape head assembly. Always try to keep magnetized screwdrivers away from the tape head.*

cast a birdbath: see ornaments, lawn
cast animal tracks: see wildlife
cast decorative concrete: see concrete, decorative
casting, fly: see fishing
catfish: see fishing

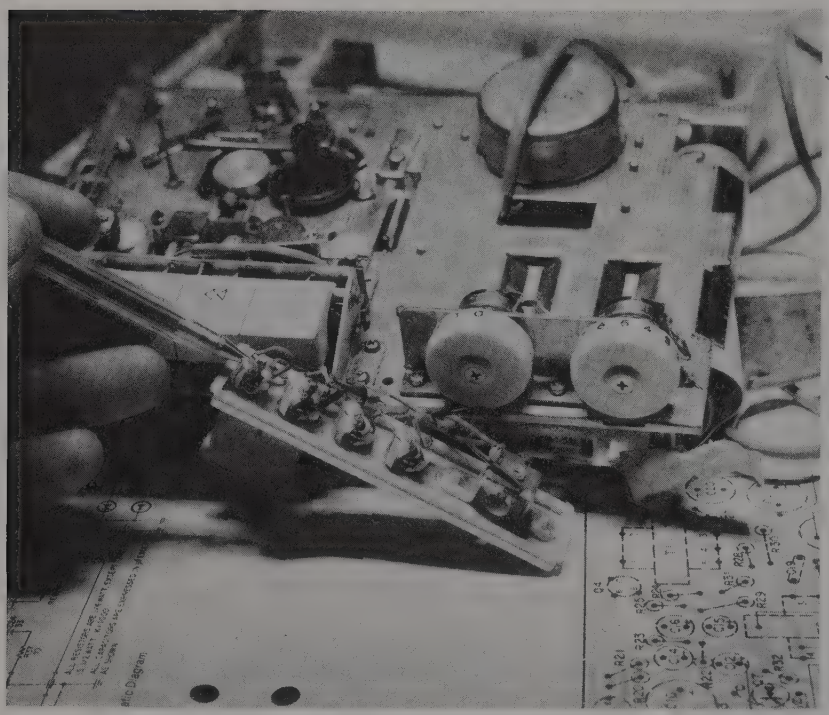
If the tape plays slow, suspect a worn or stretched drive belt. In case the tape won't move check for a broken belt. Oil on the drive belt or capstan pulley will result in slow tape movement. Clean the belt, idler, and motor pulleys with rubbing alcohol. If the speed is erratic (wow), check for oil on belt and capstan drive pulley. A belt partially off the track or a misaligned capstan assembly can cause wow conditions. Defective cassette or motor can produce erratic speed or wow conditions. After a good clean-up with alcohol, check the capstan flywheel for dry bearings. A drop of light oil on motor bearings will clear up a noisy motor. Some small motors are self-contained and do not require oiling. When you do use oil, just a drop will do; do not overlubricate any bearing. Wipe off excess oil to prevent dripping upon drive belt.





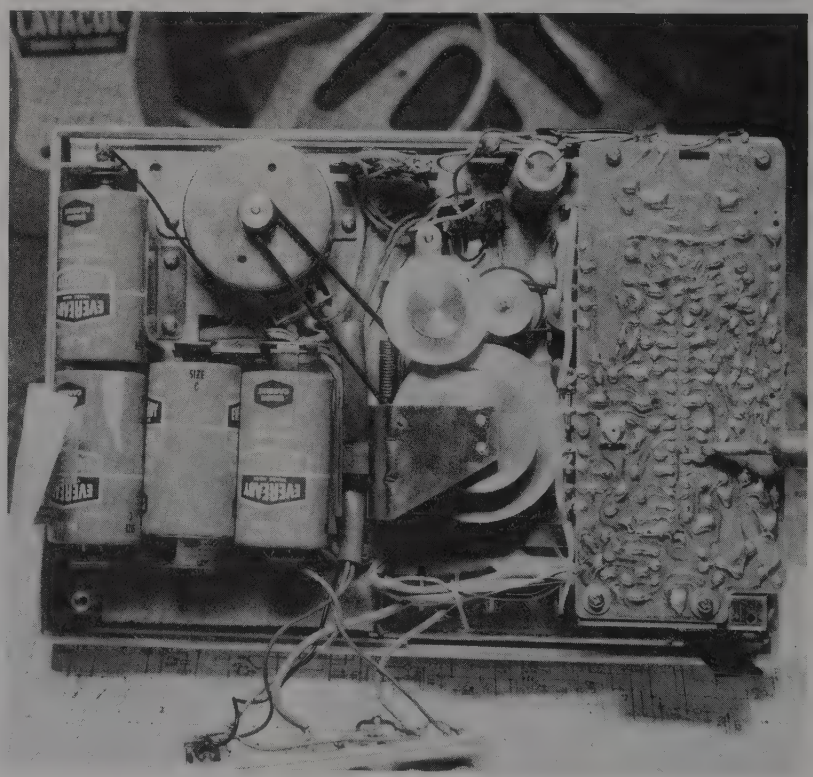
Suspect mechanical trouble when there is no tape motion and power is applied to the motor. Spin motor belt and see if the capstan drive wheel takes off. If not, remove the drive belt and see if the motor shaft is free. If not, clean out motor and bearings with alcohol, assemble and lubricate bearings. If starting is intermittent, remove drive belt and hold the motor pulley between fingers. Switch the power off and on. Sometimes under load, the motor armature will have a flat side and will not rotate. Replace defective motor. A frozen or binding capstan drive wheel will result in slow or no tape motion. Remove the capstan flywheel assembly, clean and lubricate. Wipe off excess oil. Especially, suspect dry bearings on plastic pulleys working on metal posts. Don't overlook a possible defective cassette.

Most mechanical troubles are related to the drive or switch cassette mechanism. Remove the outside case of the cassette player so you can see the mechanical action. Check the sequence of operation and try to isolate the cause of trouble. For instance, if the record button will not stay down suspect a bent lever or locking pin. In some of these small recorders the thin levers are quite fragile and bend rather easily. Remove the lever and bend back in shape. Be careful not to compound the trouble. Many of these metal parts are rather difficult to obtain and you may have to repair them. Check for broken or loose springs. You can spot these springs rolling around in the case. They can fall out in removing the outside covers. Spring replacement is difficult unless you have an exploded drawing of the mechanism.

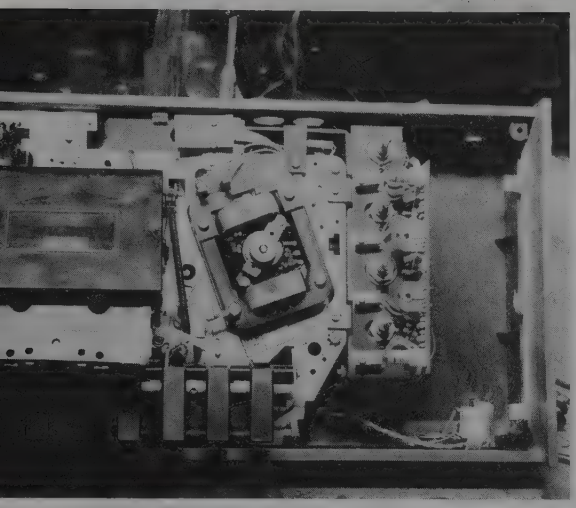


A broken remote mike cable will result in intermittent or no power supplied to the cassette player. When hum or intermittent recording is noted, suspect a defective cable. These breaks are found where the wire enters the mike or at the male plug. If the remote unit will not shut off the recorder, check for a bent female plug or defective switch. Check to see if the cassette recorder will operate without a remote unit plugged in. If not, check shorting contacts of female remote-control jack. Continuity of the remote power switch can be checked with an ohmmeter. Cut off the broken section of cable and resolder mike or plug. Be real careful in soldering the small shielded cable so that you do not solder the shield to the shielded wire. Recheck continuity with an ohmmeter.

If the unit will not record, check the microphone and mike jack. If the unit will play back a cassette, the amplifier and speaker are functioning. The trouble must be in the microphone circuit, play/record switch or switch transfer linkage. Clean and spray the play/record switch contacts. Then, check for poor soldered switch connections on PC board. Make sure the switch can be fully engaged and make contact. In case the unit will not play or record, turn volume wide open and touch the ungrounded wire from the tape head to the amplifier. You should hear a loud hum if the amplifier is working. If not, inject a signal from an audio generator at the volume control. Signal trace the defective amplifier by going from base to collector terminal of each transistor. Make voltage and transistor tests where the signal is lost. If you hear hum and the recorder will not play or record suspect the tape head.



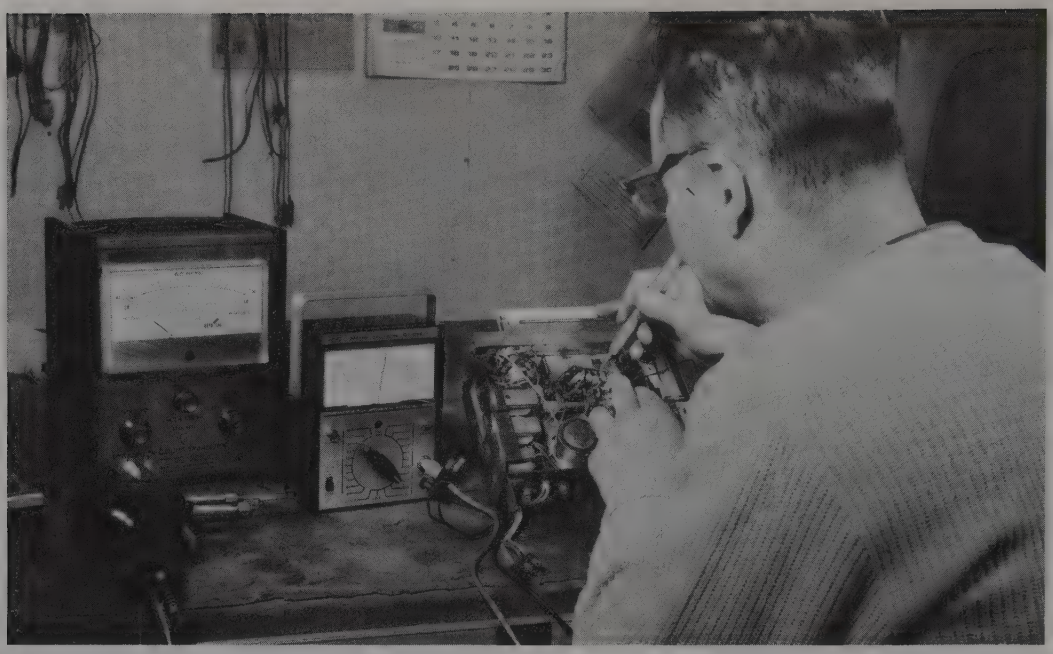
Ten Steps to Cassette Player Repair



➤ *Is your cassette player unusually noisy? Try to isolate the noisy condition in amplifier or tape head assembly. Make sure the tape head is clean and demagnetized. If the player is still noisy, see if the noise exists in a pre-recorded tape cassette. Try a few pre-recorded cassettes. Now, turn the volume down and see if noise is still present. Generally, noise produced in the amplifier is caused by leaky AF or driver transistors. Also, check for a poor ground on the PC board. The noisy transistor can be isolated by substitution or removing the collector terminal from the circuit. When the noise disappears you have located the noisy transistor or stage. A popping noise can be caused by a defective output transistor or burned resistor.*

➤ *Two recordings heard at the same time indicate crosstalk. Excessive crosstalk and poor frequency response are caused by either poor erase or improper tape head alignment. Adjust the height and azimuth screws, located at the rear and side of the tape head, to correct. Use a cassette audio test cartridge in making these adjustments. Before performing these tests clean up the tape head. Connect a 40, 47 or 49 bulb across the speaker leads. Adjust the volume control so the bulb barely glows and then adjust the tape head height and azimuth.*

➤ *Suspect a scored or rough tape drive assembly when the unit repeatedly tears tape. Check for sticky substance on capstan (tape drive) shaft. Clean the tape drive with alcohol and check for roughness. Packed tape oxide or small pieces of tape may be wound around the drive shaft and will pull or tear tapes. Make sure the drive belt is properly installed. If a new drive belt has been installed, it may be around the wrong idler pulley. This will let the tape bunch up, pull and tear out the tape. Bunching and tearing of tape may be caused by a defective cassette. Some tapes will bind and cause wow conditions. Stop the recorder if the tape has bunched up in the small plastic window. Quickly, rewind the tape and start again. If tape pulls or forms a loop, check the rubber drive belt and take-up pulley.*



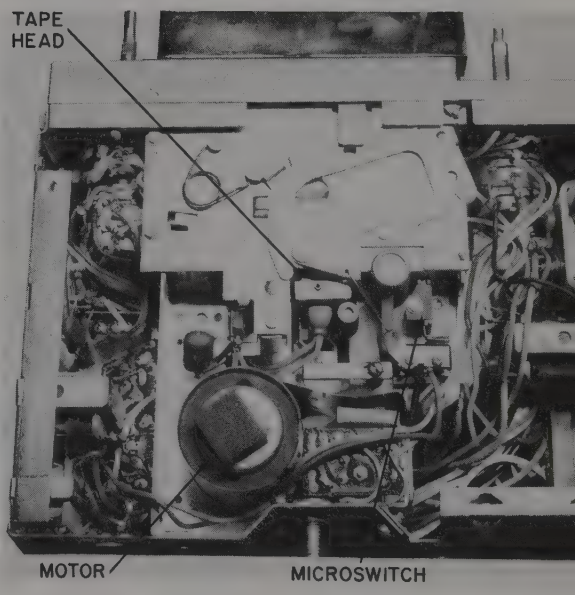
How to Repair Car Tape Players

Use these eight steps to keep your automobile tape player in good working condition

THESE EIGHT STEPS will cure most car tape player ailments, and they require only a few hand tools. Use a pencil-type soldering iron when working on solid-state circuit boards and if you have electronic testing equipment, use it, although most tape recorder troubles are mechanical.

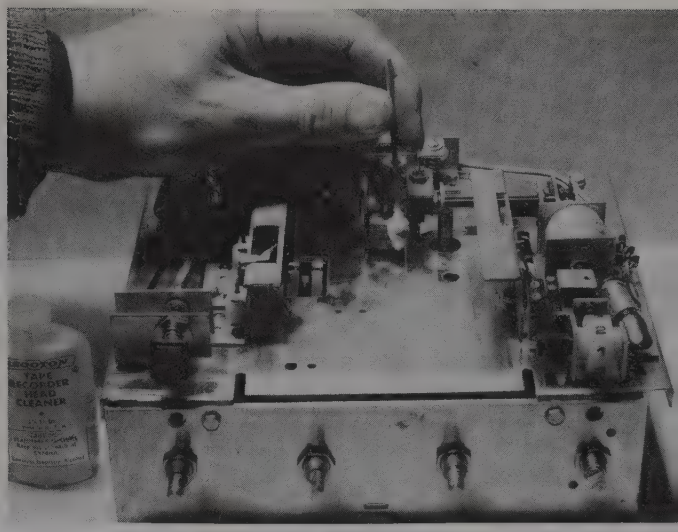
See also: ELECTRONICS; TAPE RECORDERS.

➤ *Keep your eyes open as well as your mind when you remove the car tape player from under your dash, to the time you remove the chassis covers on your workbench. Very often a loose connection or screw can be fixed, putting the player in tip top playing form. Once the covers are off, do some eyeball poking to turn up the trouble. Remember, most stereo tape player troubles are mechanical. Stop, think and try to isolate the trouble quickly before digging any deeper. And be sure not to misplace any hardware.*

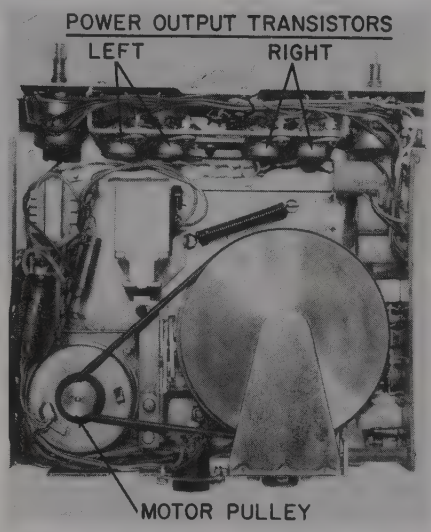


How to Repair Car Tape Players

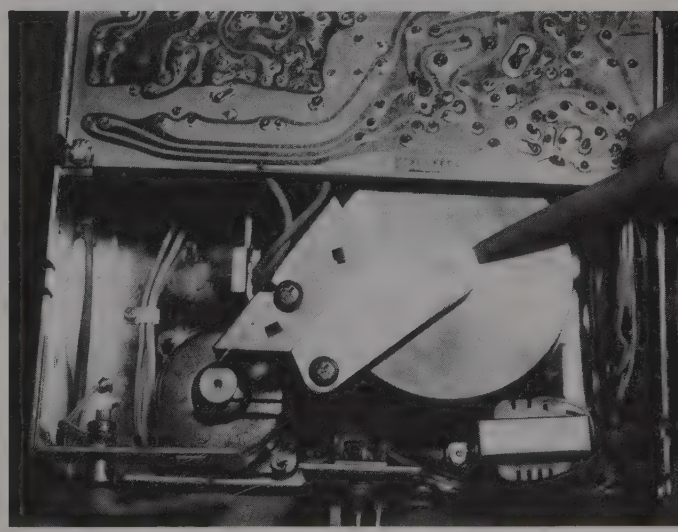
➤ *The most common trouble with auto tape machines is excessive dirt and dust. To ensure crisp tape reproduction, keep that tape head clean. A handy gadget to own is a tape head cleaning cartridge. At least once a week insert the cartridge to clean the head. At least once a year, or whenever playback reproduction is not up to par, do a thorough cleaning job. Clean tape head and tape guides with tape cleaning fluid. Apply fluid with a Q-tip. Denatured alcohol can be used. Also, remove tape oxide dust from head and motor capstan drive. Poke around and clean it all up. However, be sure not to throw any tape guides out of position.*

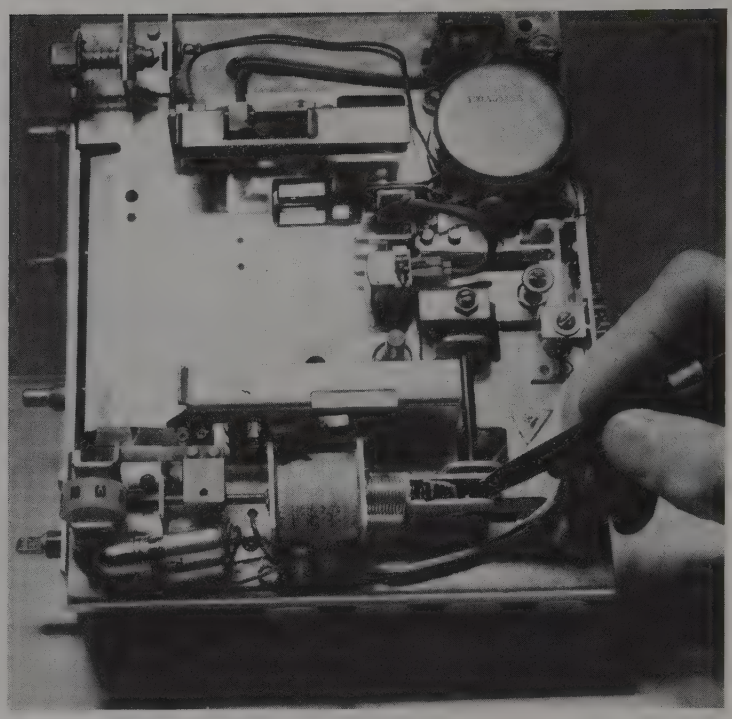


➤ *In many cases, dirt and grease will collect on the motor drive pulley and nearby metal parts. Simply remove all dirt and grease with denatured alcohol. Also, check that capstan flywheel and clean it if necessary. A bright slick-looking flywheel indicates slippage between the drive belt and flywheel. Clean thoroughly. If at all possible, try to find a replacement drive belt. You may have to write to the manufacturer. Power output transistors are installed with hardware that can loosen, causing poor electrical connection. Also, if not seated tightly on their heatsink surface, the power output transistors can overheat and destroy themselves. Be sure they are secured in their sockets.*

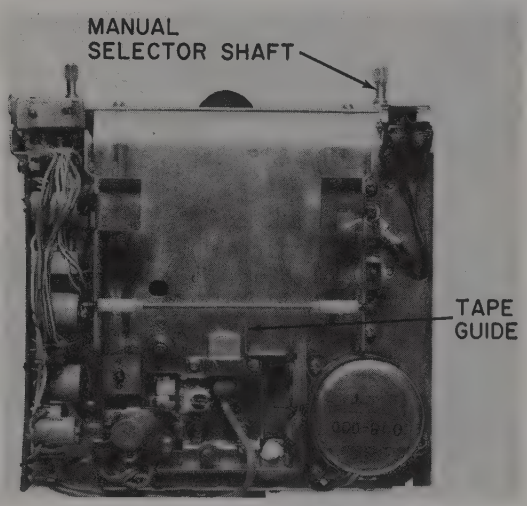


➤ *Excessive tape oxide dust within the flywheel bearing will cause slow and erratic tape speeds. Most capstan flywheels can be removed by pulling out a small keeper pin at the bottom bearing assembly. Now it will be easy to clean all bearing parts and surfaces nearby. Put a drop of oil into both bearings and re-assemble. Let the tape player run for a few minutes on the test bench and check for any oil that may work on the flywheel drive surface. Over lubrication may undo any good achieved.*



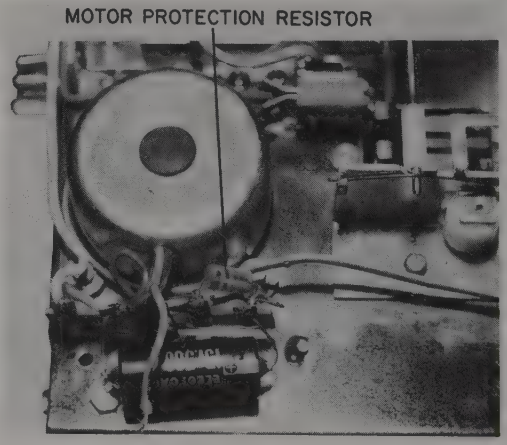


Does the tape refuse to change to another channel? Or perhaps, the solenoid is working and the channel indicator does not move? To find out what's up, connect power to the unit and listen to determine whether the solenoid is operating or not. A channel change can easily be heard while watching the ratchet. Determine whether the ratchet is turning over a small cam that lifts and lowers the tape head. Eyeballing it here will pinpoint simple mechanical problems that you can adjust to normal operation order. If the solenoid does not operate, it may be shorted out or have an open coil—call your VOM into action. If your playback is erratic or dead, check the shielded cables to the tape head. They can cause lots of trouble. If inspection does not pinpoint the cause of the trouble, you'll need the services of a signal tracer or injector. Be sure the volume control is set wide open.



In case the stereo tape player will not manually change channels, suspect a dirty or broken manual change switch. Momentarily short the two contacts at the back of the change switch. If the solenoid is operating, the tape head will change positions. If not, trace out the wiring and look for a cold solder joint or break. If the switch is loose, it will promote frayed and broken wires. Try to determine cause of failure to prevent its recurrence.

Generally, when the tape becomes wound up into the capstan drive assembly, suspect a rough capstan drive or a poor cartridge. Do not allow the machine to run when jammed with tape. The motor will overheat. In this particular model, the motor protection resistor in series with the power supply burned out and was replaced. Most values are low—like 2.2 ohms. However, check the unit's schematic diagram to determine correct value and wattage. Of course, overheated motors often become defective and replacement is mandatory.



How to Seal Your House against the Weather

Use a caulking gun to protect your house against deterioration and cut heating and air conditioning costs

Caulking of house siding at all joints protects against the ravages of weather, seals out drafts and insect penetration.

CAULKING is an essential maintenance chore for sealing out winter drafts and protecting the home against deterioration. Every house, no matter how new and well-built, has cracks and crevices at wall joints, around door and window frames, and at the chimney and foundation line. Unless sealed, these openings allow entry of rain water, insects, and wintry blasts. Caulking should be done each year, replacing old and checked compound.

Caulking means applying a bead of a long-lasting elastic compound over the wall joints and crevices. The compound comes in a paper cartridge with a nozzle at one end. This is loaded into a spring-actuated "gun" that applies pressure to squeeze the compound slowly out of the nozzle. The trick is to lay in a straight, thin bead of the compound directly onto the wall joint or crevice. The technique, described later, is not at all difficult and is easily mastered after a bit of experience.

In addition to the usual purposes, the caulking gun is useful for applying contact cement when installing wall panels and ceramic tiles, and for caulking the seams of boats.

Exterior house caulking is best done on a warm day, in either spring or autumn, when the compound will flow more readily. Make sure that the joints to be sealed are completely dry and clean. Use a putty knife to chip out all remnants of old compound that has split or lost its bond to the wall. Brush away all chips, sand and dust to assure a good bond of the compound.

A list of places to caulk on exterior walls includes all door and window frames, joints where the wall siding meets the chimney, seams of the siding and any wall projections such as soffits and overhangs. At door frames, do the top and two sides; at windows, seal the joints all around with par-

cb: see citizen's band radio
cedar closet: see closets
ceiling beams: see garage remodeling
ceilings: see panels

ticular attention to the space underneath the sills. Also, look for and plug all wall openings at utility entrances, exterior lighting fixtures, and lawn faucet outlets.

The caulking gun is loaded by twisting its pressure rod to disengage it from the spring ratchet, then pulling the rod back as far as it will go, so the cartridge can be inserted. With shears or scissors, snip off about a half-inch length of the plastic nozzle, providing a generous opening for squeezing out the compound. Also be sure to puncture the sealed cartridge with a nail or awl.

Turn the handle back to center position and work the trigger two or three times, bringing the spring pressure plate into contact with the cartridge. The gun is now ready for use. Further pressure on the trigger will force out the compound like toothpaste from a tube, but there is a difference —the compound will keep oozing out and, if the nozzle were placed onto a wall joint, would build up into a massive pile, even without pulling the trigger. But there is a way to control this: as soon as you come to the end of the crevice, swing the handle rod half a turn; that releases the pressure and the flow stops almost instantly.

Now for putting the compound on the wall. Place the tip of the nozzle at one end, tilted slightly. Pull on the trigger and start moving the nozzle slowly and steadily along the joint, the speed depending on how fast the compound is flowing. Press the nozzle down as you go for better adhesion of the compound to the surface. Avoid hesitant or jerky motion. If you have to stop, or have come to the end of the joint, quickly swing the handle rod to stop the flow. You can't expect to do this expertly the first time around, but after a little practice it will go very smoothly and easily.

Here's a tip for neater caulking. With a cloth dipped into the proper solvent, or moistened with water if you are using vinyl compound, run it along the bead to smooth it to a uniform thickness and at the same time pressing it down for a firmer bond.

There are now numerous types of compounds, each specially formulated for particular applications. The traditional caulk for wall sealing purposes consists of a mixture of pigments and binders, blended with linseed oil. But the wider use of latex paints has prompted development of compounds with vinyl or acrylic base that are more compatible with latex paints and have less tendency to shrink.

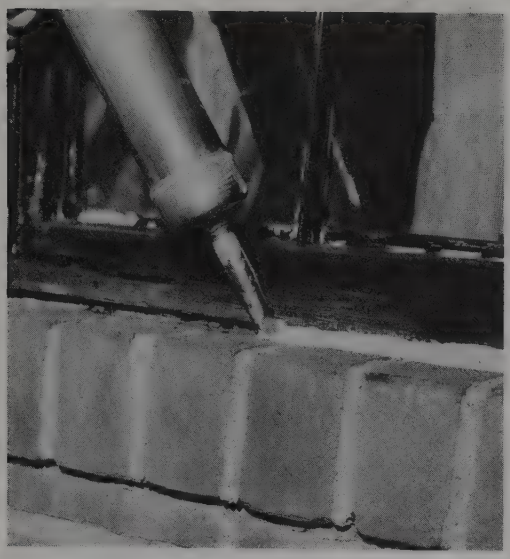
Latex compounds have additional advantages. They dry quickly and can be painted over without waiting. They are thinned with water, making cleanup easier than with oil-base types, which require a mineral solvent.

The silicone rubber products of Dow Corning and General Electric are also an important advance, not only as joint sealers but for an amazing range of repairs such as awnings, toys, tents and plumbing lines, insulating electrical fixtures, and as a substitute for gaskets.

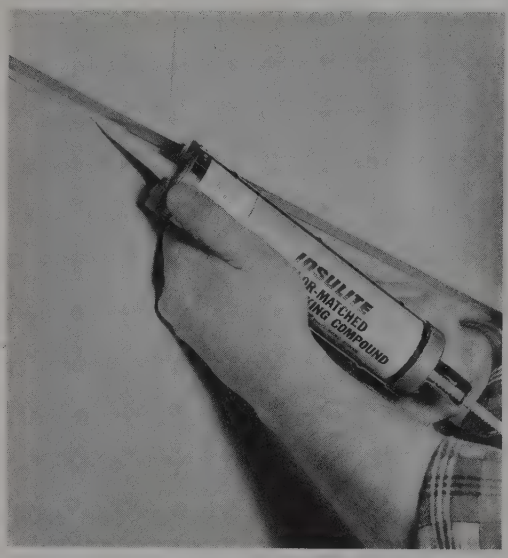
Other special types of compound are polysulfide rubber base, for sealing joints of dissimilar materials and where there may be excessive movement; neoprene and butyl rubber for flashings and roof gutters, also as a putty for window and shower door glass.

Although most caulking is done with the pressure gun, there is a prepared rope form, Mortite, that is simply pressed onto the crevices. The rope caulk will be found convenient for temporary weather-stripping around doors and windows, and for packing wall openings at utility entrances.

Bathtub caulking. Handy tubes of silicone rubber compound with their own nozzle speed waterproofing of the wall joint around the bathtub rim. The surface must be clean and dry. Chip away all loose tile cement and old compound, wipe and vacuum. The width and depth of the compound bead that will be put down depends

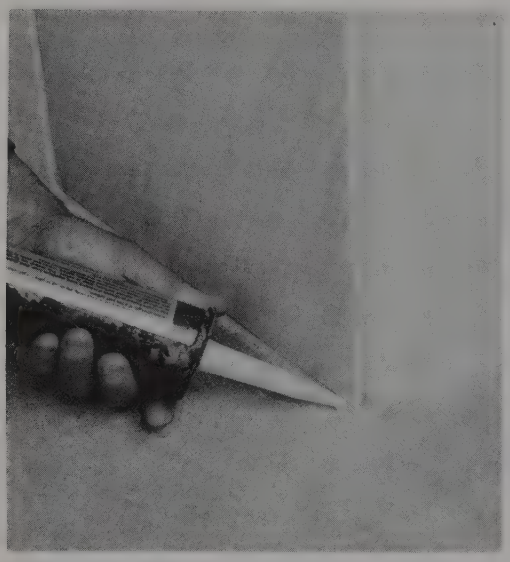


▲ *Window sills are particularly subject to warping, which may leave an open crevice. Caulk all window and door frames carefully.*



▲ *Joints of siding panels are sealed with bead of caulking compound. Move gun steadily with slight pressure on trigger.*

▲ *Butyl rubber compound is effective on metal roof gutters and flashings. Seal assembly joints to stop water leaks.*



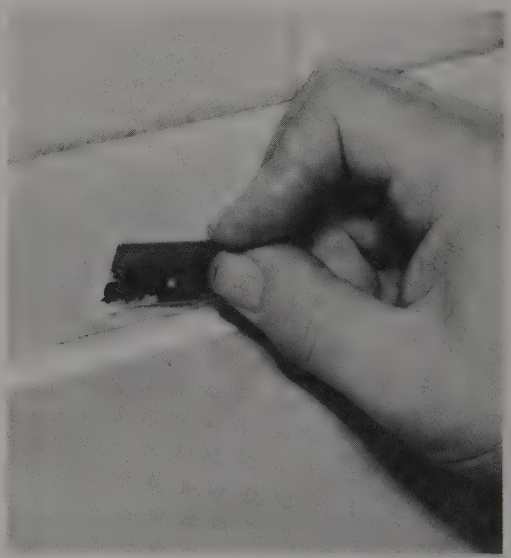
▲ *Expansion joints in underlayment panels on bathroom floor should be waterproofed with correct type of caulking compound.*

on the nozzle opening; cutting back about half its length usually is best. Hold the tube at a slight angle, pointing in the direction that the compound will be applied, move the nozzle forward, which in effect pushes the compound ahead of the nozzle and produces a neat bead. The caulk dries to the touch in an hour, but is not fully cured

Cracks in concrete surfaces such as driveway, sidewalks, patio are plugged with special sealer to stop water entry and freezeup.

Sink and tub rims are sealed with silicone type plastic direct from the tube, after cutting nozzle to required opening.

Use wood spatula to compress the caulk along the joint line, forcing the compound into the joint. Follow with damp cloth to remove excess.



Razor blade trims the caulk line for neatness. Cleanup for vinyl and acrylic compounds is with water. Oil-base and silicone rubber require mineral solvent.

for about 24 hours when it can be trimmed where necessary with a razor blade.

The silicone rubber compound is useful also for repairing worn gaskets on automobiles, sealing windshields, refrigerator and dishwasher doors, aquariums, even rubber boots. **R.T.**

See also: WEATHER-STRIPPING.

Direct Ceiling Installation

How to attach ceiling tiles directly to existing plasterboard or to bare joists—without using furring strips

When your plasterboard ceiling begins to show stains, popping nailheads or joint separation, you can tile a new ceiling right over it, as long as the old ceiling is structurally sound.

ONE EASY WAY to improve the appearance of a stained or cracked plasterboard ceiling is to cement a new acoustical tile ceiling right over it.

You can do this with ordinary fiberboard ceiling tiles with beveled edges, but if you want a surface without a grid pattern, you can use tiles whose edges are butted flush so that the joints are not easily visible. Additional camouflage of the joints comes from the use of a random pattern embossed on the surface of the tiles.

Tiles like these are manufactured by Armstrong Cork Co., as are fittings that can be used to attach the tiles directly to the joints of an unfinished ceiling. This can be done without the laborious installation of furring strips. With additional fittings, you can use the tiles for a suspended ceiling.

Cementing tiles to an existing plasterboard ceiling is simple. Just brush a dab of ceiling cement—available from the tile dealer—on the four corners and center of the tile and press it into place. Then, put two staples into each exposed flange to hold the tile while the cement gains adhesion. Start in one corner of the room and work your way across the ceiling.

Attaching the tiles to the exposed rafters of an unfinished ceiling is only slightly more complex than cementing them to plasterboard.

The first step is to nail a molding—of any type you choose—around the walls 1⅜ inches below the level of the joists. The molding supports the outside edges of the border tiles.

The balance of the tiles are supported by a system of joist clips and T-rods. To attach a clip, press it on the joist and pull it downward so its teeth dig into the wood. A slot in the bottom of the clip engages and holds the vertical member of the T-rod.

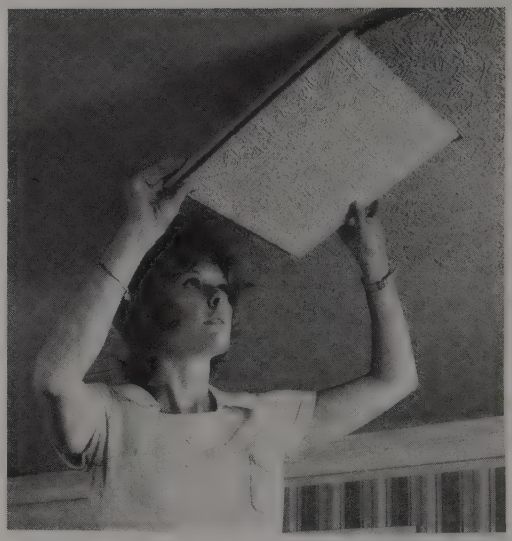
The T-rods are installed so the T is upside down. The shoulders of the T slide into kerfs in the long edges of the tiles.

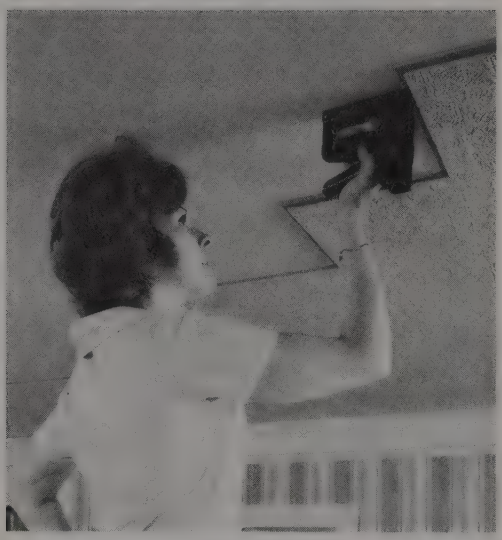
Install the first tile in a corner, so that the long dimension of the 1 x 4-foot tile runs across the joists. The inside edges are supported by the molding. Hold the T-rod so the vertical member points up and press one side of the cross member into the kerf of the tile. Then press a clip onto the joist. Push the tile up so the vertical member of

cellar: see basements
cellulose nitrate cement: see adhesives
centipedes: see pest control
central air conditioning: see air conditioners
ceramic bathroom tile: see bathrooms

Five dabs of cement per tile—arranged like the pips on a playing card—are used to stick the tile to the ceiling. Keep the cement away from the edges; when the tile is pressed against the ceiling, the cement spreads.

Tongue and groove edges of the tile slide together so visible edges are butted flush.

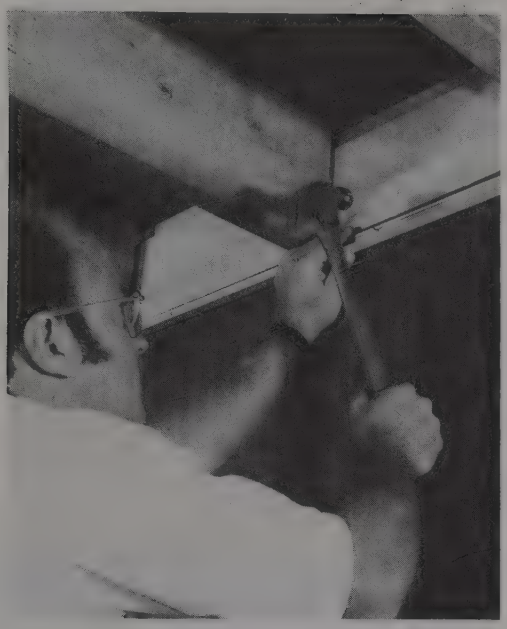




Staple exposed flanges of each tile to hold it in place while the cement sets.

The completed ceiling. Joints between tiles are not invisible, but they are rarely noticed because of the flush butting and the camouflaging effect of the random pattern embossed on the surface.

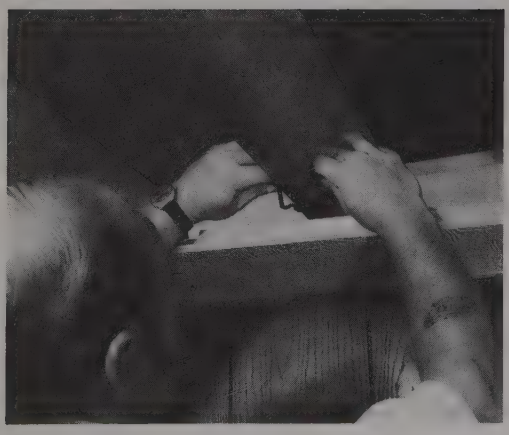
Direct Ceiling Installation



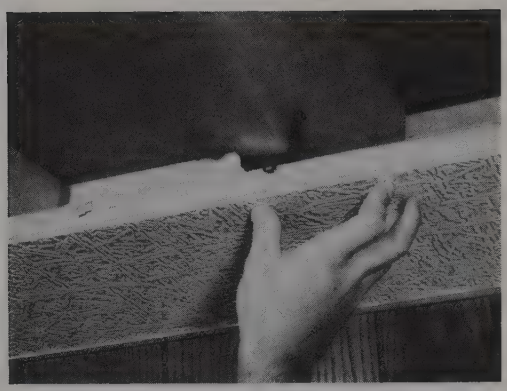
Ceiling tiles can be attached to joints directly without the use of furring strips. You can do this with a system of T-rods and clips. Start by nailing a molding around the room $1\frac{3}{8}$ inches below joist level. The molding shown here is metal, but wooden molding will do.

Lay the first tile in place in a corner, so that the long dimension is perpendicular to the joists.

Slide one side of the cross-bar of the T-rod into the kerf in the edge of the tile. The vertical leg of the T points up.

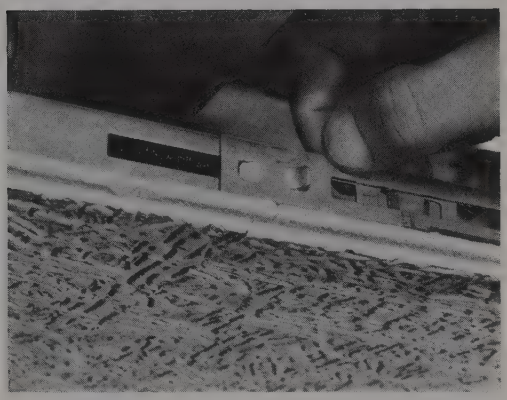


Support each T-rod with at least one joist clip. Slide the clip onto the joist by spreading the legs. Pull down slightly so the metal teeth of the clip dig into the wood.



Push up on the tile so the vertical member of the T-bar engages the slot on the bottom of the joist clip. This completes the installation for the first tile.

Install tiles, T-rods and clips to the end of the row. Trim the T-rod and tile. Start next row with leftover piece of tile. Continue, a row at a time, until the job is completed.



Interlocking ends of T-rods provide continuous support for the ceiling.

The completed ceiling presents a clean, continuous surface, in which the joints of the tiles are barely visible.

the T-bar engages the slot in the clip, and that's it. The tile is in place.

Continue the first row all the way across the room. The ends of the T-rods interlock. When you arrive at the end of the row, trim the T-rod with a hacksaw or tin snips and the tile with a knife. Use the leftover piece of tile to start the next row at the opposite end of the room. Just press it in place so the kerf on the edge away from you mates with the exposed shoulder of the T-rod. Then install a T-bar and clip on the edge near you. Continue in this manner until the job is complete.

See also: ADDITIONS, HOME; HOME IMPROVEMENTS; STAPLE GUN.

A New Ceiling with Furring Strips

Use acoustical tile and furring strips. It's easy to do, and the results will make your home quieter as well as improve its appearance

CEILING TILE INSTALLATION is fast and relatively easy. It is among the most common do-it-yourself projects, and in many homes the most needed—for appearance as well as for reduced sound levels.

Psychologists long ago demonstrated that irritating noise levels in factories and offices lower efficiency because they reduce comfort and cause fatigue.

The same conditions create similar results in the home. Recently a university research group measured the noise level of a typical home with sensitive instruments. At times, readings were as high as 60 decibels, about equal to the level of noise on a busy downtown street.

The racket comes from at least 12 sound-producing appliances in the average house, plus children, plus perhaps a dog. Here's what happens to fray the nerves:

If all surfaces of the room are hard, the sound bounces back and forth from one surface to another, up and down and across the room. Your ear is unable to separate the individual returns into distinct sounds, and the multiple reflections appear as a mass of sound, from which it becomes difficult to pick out individual vocal sounds, or words.

Sound absorption of materials reduces this reverberation. When perforated or fissured acoustical tile covers the ceiling, the tiny noise traps in the tile absorb some of the sound waves, cutting down reverberation time. Thus, successive syllables arrive at the ear of the listener distinct and free from each other. You don't have to speak as loudly to be heard distinctly.

Draperies, overstuffed furniture and soft wall surfaces also absorb sound. But it is on the large ceiling area that most can be done —while covering unsightly chips and cracks at the same time.

In sound-conditioning your home with ceiling tile, remember that there are limitations to what any material in a particular installation can do. An acoustical ceiling will not stop sound going from one room into another; nor will it decrease impact transmission.

When sound is produced in a room, part of it reflects off the room's surfaces; another part is absorbed by the surfaces; and a third part is transmitted to the other sides of walls, ceiling and floor.

Ceiling tile will decrease reflection and increase absorption, but will not affect airborne sound transmission—except some of

that which would go through the ceiling. The walls still will act as sounding boards, reproducing the sound waves on the other side. And conversation or other sound will still go freely through door or window openings, or through cracks around doors and windows.

Impact transmission is that sound carried through a building by vibration of the structural materials. A footstep on the floor above will be muffled somewhat by ceiling tile's resistance to vibration; but a footstep in the room itself will be transmitted along the floor boards just as easily as if there were no ceiling tile.

Through-the-wall transmission can be decreased by weaving insulation between staggered wall studs during construction, or by covering the wall with a stable material like fiberboard. Impact transmission can be muffled by floor rugs or resilient floor tile.

There are several types of ceiling tile and a wide variety of decorator styles. As a do-it-yourself installer, however, your choice will probably be fiberboard tile in 12x12-inch squares of wood or sugar cane fibers.

Other materials include mineral fiber tile, glass fiber, perforated metal pan acoustical systems (with fiberboard backup) and even gypsum tile and asbestos-cement tile. And today there is a rising trend toward suspended ceilings—acoustical tile laid in metal channels so they may be easily removed to add or repair wiring or plumbing. The latter are becoming increasingly available and popular for homes.

Surfaces of the residential-type tiles may be perforated or fissured. In each type of treatment there is wide variety of pattern and color. Among perforated tiles, punched holes in different patterns are standard. But micro-drilled perforations, made by as many as 1500 tiny drills on a 12-inch square, are becoming popular because they allow a wide range of surface treatments.

Depending on decorative treatment, the cost of each tile runs from 15¢ to 40¢. Since the tile is 12 inches square, that makes a cost of from $18 to $48 for a 10x12-ft. room, plus a few dollars for furring strips and staples, or adhesive if you use that method of installation.

Once installed, cleaning is easy, too, and there is rarely need for repair. Though sound-absorbent, ceiling tile is not more smoke- or dust-absorbent than most other materials; it stays clean-looking for a long time. Pliable wallpaper cleaner or a vacuum cleaner can be used between paintings.

When it comes time to redecorate, you can brush or spray-paint perforated tile up to 20 times without reducing sound-absorbent efficiency to any great extent. Fissured (textured) tile is best sprayed but can be brush-painted five to ten times with little loss of efficiency.

Amount of absorption. In selecting the tile to use, you may run into the term "coefficients of absorption." This is expressed in hundredths and varies according to the number of cycles of the sound waves concerned. You'll find different tile of the residential ½-inch thick type with coefficients ranging from .60 to .75 or thereabouts. Or you may find a range of coefficients as in the chart.

"Coefficients of absorption" is simply the scientific way to indicate how much sound the tile will absorb. Most household noises are in the medium-frequency range. In the chart, .78 under 1000 cycles means simply that a common noise of that frequency will

COEFFICIENTS OF ABSORPTION	125 Cycles	250 Cycles	500 Cycles	1000 Cycles	2000 Cycles	4000 Cycles	NRC Range
Cemented to plaster	.10	.19	.64	.78	.72	.52	.55-.65
Stapled to furring	.11	.57	.54	.66	.71	.54	.60-.70

be reduced by the tile absorbing 78% of the sound. That's good performance, and explains why ceiling tile increases home comfort.

Application methods. When you have selected the tile, you'll be guided in method of installation by the condition of the ceiling, plus your own preference.

Tile can be cemented to a finished ceiling in good condition. But if your ceiling is so badly cracked and crumbly that it won't support a layer of tile, or if it is an unfinished ceiling with joists exposed, it's simple to cover the area with nailing strips, crosswise to the joists at 12-inch intervals, and staple the tiles in place.

Some manufacturers recommend that do-it-yourselfers use only the furring strip application method regardless of ceiling condition. They say that adhesive application methods are a little trickier for the unskilled.

The choice, however, is up to you, and both methods are excellent when properly done to a ceiling in the proper condition. Layout is different in each case, and you may select either ashlar or regular pattern.

Determining tile location. First, accurately measure the ceiling's width and length. Draw these dimensions on a sheet of paper to determine the number of tiles to be used. The example in the drawing is a room of uneven dimensions, 8 feet, 6 inches wide by 10 feet, 8 inches long.

In this example the width of the room would take eight 12-inch tiles and leave 6 inches to be divided in half for two 3-inch borders. Such narrow borders are not desirable, however, so it would be far better to take away one full tile, leaving seven, and then divide the extra 12 inches thus provided between the two borders to end up with 9-inch borders.

By the same formula, nine full 12-inch tiles would be used in the room's length, with two 10-inch borders.

If you are using 16-inch square tile, convert the room measurements into inches; divide the total number of inches by 16; then divide the odd number of inches left over by two and add 8 inches to each border thus resulting. When you then take away one full tile, the formula is complete.

Installing on furring strips. If the ceiling is finished, locate the ceiling joists by tapping. Generally, joists are on 16-inch centers and run the short way of the room. However, they might be on 24-inch centers, and they might run lengthwise. If you have trouble locating the joists, drill successive small holes along a cross pattern until you find one, then measure out 16 inches to drill-locate the next.

Now place the first furring strip flush against the wall at right angles to the joists and nail into place with one or two 8d nails at each joist crossing. Then, using your paper computations and drawings, mark off 12-inch-on-center points along each short wall for the furring strips. Mark the locations of the joists on the finished ceiling and nail all 1 x 3-inch furring strips in place.

Make sure the strips will provide an even base by checking them with a straight board or a carpenter's level. Drive thin strips of wood or ordinary cedar shingle pieces between the strips and the joists to even out low spots.

To mark position of the border tiles for the long wall, snap a chalk line along the center of the second furring strip, tying the chalk line to nails temporarily driven into the strip at the correct distance from the wall. When you staple the tiles into place, their flanges should fall exactly on this line.

Now snap a chalk line across the furring strips to locate the border tiles for the short wall. Use the same procedure as before. To get a sharp impression with the chalk line, stretch it as tight as possible between the nails, pull it down about an inch at the center and let go.

When this is done, cut your border tiles to size. Remove only the tongue edges; the

stapling flanges must remain in place. Place the tile face up and measure to size, including in the measurement only the face and bevel of the tile—not the flanges. Mark with a pencil and cut with a coping saw or a sharp fiberboard knife drawn along a straightedge.

Now install the first tile in the corner of the room. Then install the remainder in the sequence shown in the drawing.

Use three staples in one flange of each 12-inch tile and one staple in the other flange. For 16-inch tile, use four staples in one flange and one in the other.

Nails can be substituted for staples if you prefer, or if you don't have or can't rent a stapling gun. However, nailing is slower, more difficult, and may result in damaged edges from badly aimed blows.

Ashlar pattern layout. If you prefer an ashlar pattern, in which the edge of each tile falls at midpoint of the one adjacent to it, you can change the installation procedure in this way: Snap two chalk lines across the furring strips (along the short wall). The line furthest from the wall should be located as previously described, and the other 6 inches closer to the wall in the case of 12-inch tile (8 inches for 16-inch tile). Tile No. 1, then should be cut so that it follows the single line along the long wall and reaches the outermost line along the short wall. The next tile, coming out from the short wall, will be left its full 12-inch width (along the short wall) but should be cut to reach out from the short wall only to the innermost line.

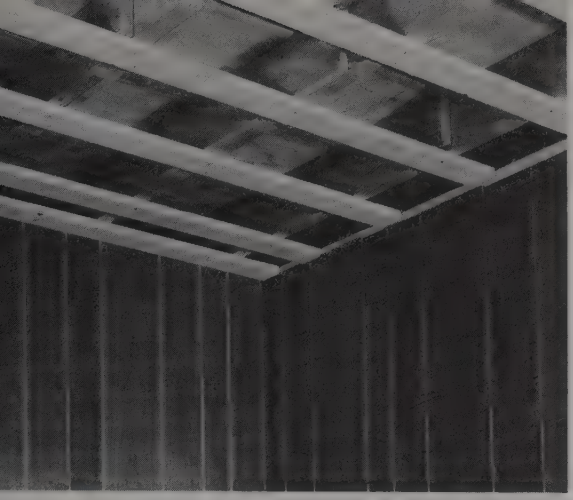
Cementing tile with adhesive calls for a different procedure; you start in the center of the room rather than in a corner.

Measure along the sides of the room to find the centerlines and snap chalk lines between midpoints of each wall. Now check against the paper layout with which you determined the border widths. If the center of a tile, rather than the corner, fits over the center point of the room ceiling (that is, if you cannot achieve the scale layout by using the center point chalk lines), snap secondary guide lines half the tile width to one side of the center lines. The first tile will then fit with its corner at the intersection of the guide lines.

Starting the tile in this manner, you will wind up with four equal quarters of the room to work with individually. If the room is square, your borders will be even. If you have to shift with secondary lines as described, the room will not be done in equal quarters, but the borders will be equal for each pair of edges.

To cement tile in the ashlar pattern, snap center lines as before. Then snap another line the short way of the room,

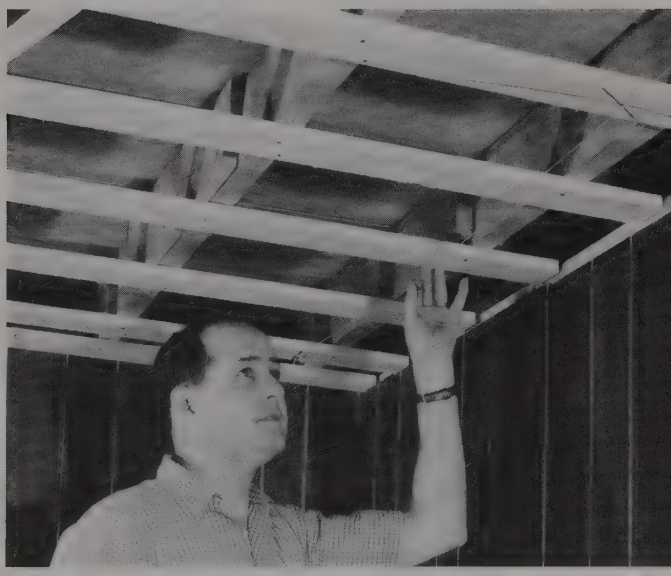
➤ *Furring strips for ceiling tile can be nailed directly to exposed joists. If the ceiling is plastered, the strips can be nailed to the joists through the plaster. To start, nail a furring strip across the joists flush to the wall at each end of the room. Use two 8d nails at each joist.*



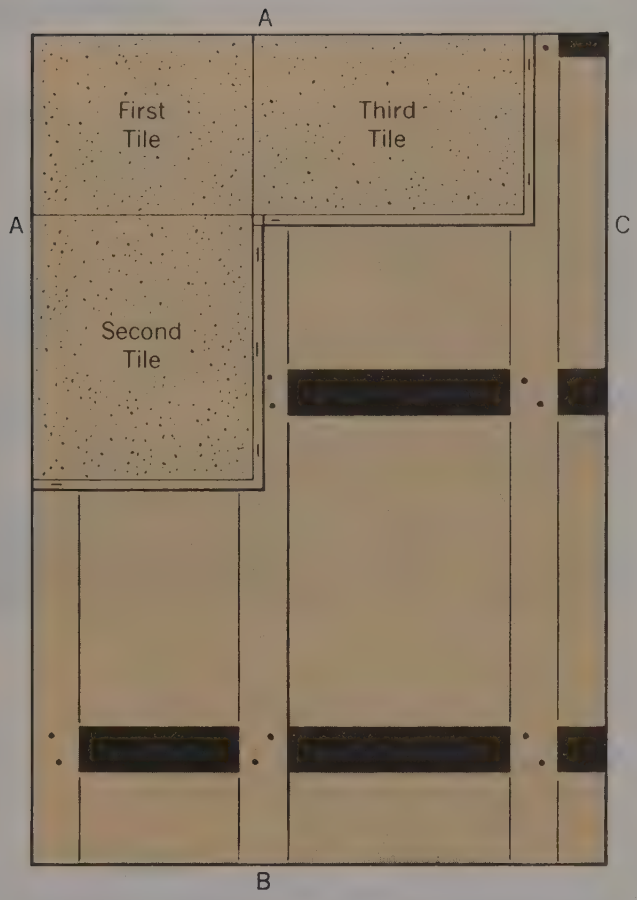
Placement of the second strip depends on the width of the border tiles that will go along that wall and the opposite wall. To determine border width, measure the distance across the room. If it is an exact number of feet, with no inches left over, the border is 12 inches wide, the same as every other row of tile. If the distance measures out to feet and inches, divide the number of inches by two and add six inches. The result is the width of the border. Use the same procedure to determine the width of the border for the other two walls.

When pipes or cables are hung beneath joists, use a double layer of furring strips to get the ceiling below the projections. The first layer of strips should be nailed on about 24-inch centers. The second layer of strips should be nailed across the first layer and spaced to accommodate the tiles. Where possible, nail through both strips into the joists.

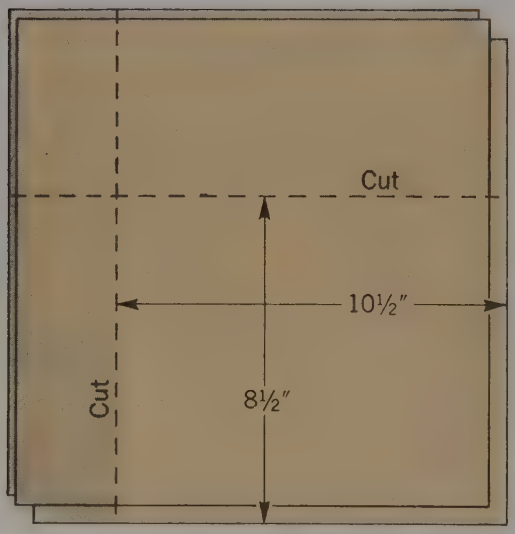
Make sure furring strips will provide an even, level base for the new ceiling. Check evenness with a carpenter's level and drive thin shims of wood between strips and joists where necessary to even out low spots.



Use guide lines to mark the position of border tiles. This keeps the ceiling true even though the wall may have some irregularities. Make the lines by snapping a chalk line across the furring strips at the proper position along each of the four walls of the room.



Start installing tiles from the corner in the order shown. To trim tile, measure the dimensions, then cut face up with a sharp knife. Note how three staples are used on flange that runs along furring strip and one staple on the flange that runs across the strips.



spaced half a tile away from the first. Start tile No. 1 as before, but stagger the next tile.

Since the tiles go up quickly, a plank over two saw-horses or a scaffolding will allow you to cover more territory without stopping to climb up and down. Arrange a box or bench with two piles of the tile, back side up.

The cement should be placed in the shape of four walnut-sized balls near each corner of a tile. With cement still in ball shapes, line up the tile for application and press into place. Use the back of your hand to press firmly and evenly. Keep tiles lined up and close together.

A brush-on cement is also available. This cement is easier to apply and permits flanged tile to slide into tongue-and-groove connections more readily than balled cement. The latter is intended primarily for use with an unflanged tile which is butted up to the adjacent tile.

Whichever method you use—and you should check your supplier for his recommendations—remember that the result depends on how well you do the job.

Finishing touches. When the tiles are in place, you can finish off the room nicely with one of a number of attractive cove moldings. Use 3d to 6d finishing nails to apply such molding, nailing it into wall studs whenever possible in preference to nailing through the tile into furring strips or joists.

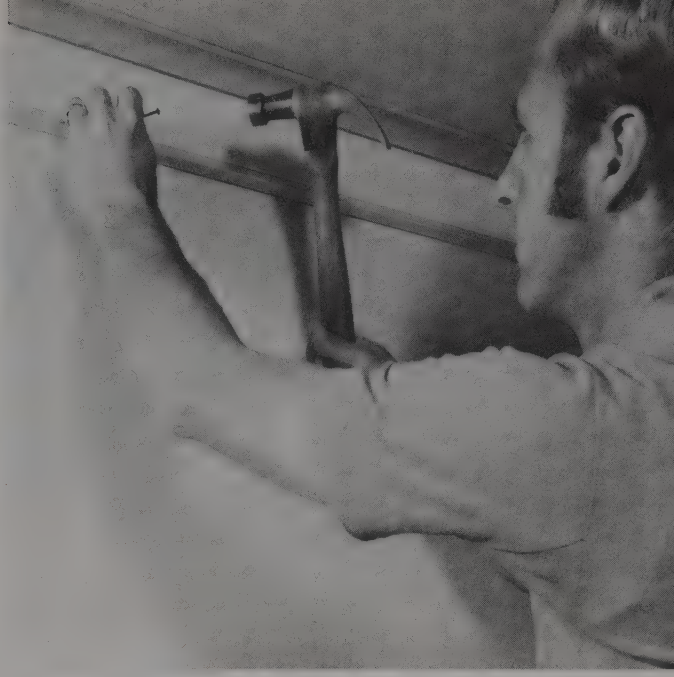
There may be some on-the-spot deviation necessary from the exact procedures outlined. For instance, a room with a closet extending out into it may require that you shift the tile layout lines slightly to avoid ending up with narrow borders along the closet wall.

Take one step at a time, follow recommendations carefully and you'll find that sound-conditioning is an easy and satisfying project.

See also: HOME IMPROVEMENT; STAPLE GUN.

Install a Suspended Ceiling

With new hardware and materials, this work can be done easily by most homeowners



Nailing a molding around the room is the first step in the installation of a suspended ceiling. The molding shown is an L-shaped metal type, but almost any kind of molding can be used.

INSTALLING A SUSPENDED CEILING is not much more complicated than attaching tile directly to an old ceiling with furring strips, and it can solve several remodeling problems.

First, suspending a ceiling is the easiest answer when the original ceiling is too irregular for the direct attachment of tile.

Second, suspension is the best way to bring a ceiling beneath any ducts or pipes that project below joist level, as they might in a cellar.

Third, if you wish to use flush lighting, a suspended ceiling can readily accommodate this kind of fixture.

There are several types and brands of suspended ceiling hardware sold by building supply houses and lumberyards, but they all work on about the same principle. One of them is Armstrong's Integrid, which is described here as an example. One advantage of this system is that the finished tile ceiling has no visible gridwork. The joints of the flush-butted tiles are not noticeable.

To start, nail a molding around the room with the top of the molding at ceiling height. The outside edges of the border tiles will rest on the molding.

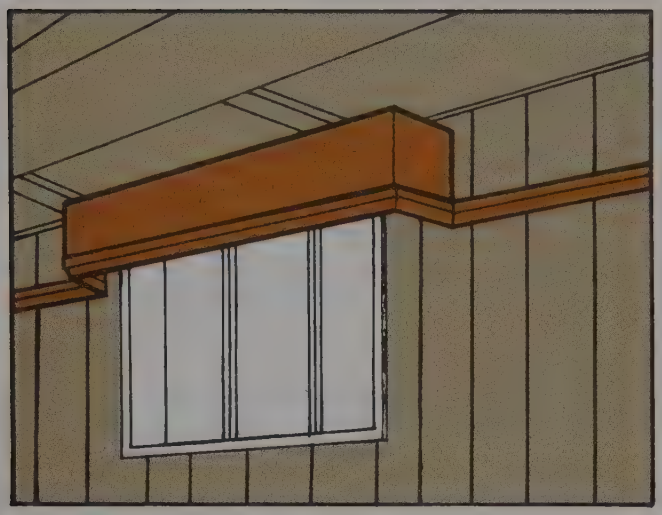
The main runners are installed after the molding is in place. They hang by lengths of wire from screw eyes driven through the original ceiling into the joists.

After the joists are located, snap a chalk line on the ceiling perpendicular to the joists 26 inches from the wall. Then, snap chalk lines parallel to the first line at four-foot intervals across the room. Each chalk line marks the position of a main runner.

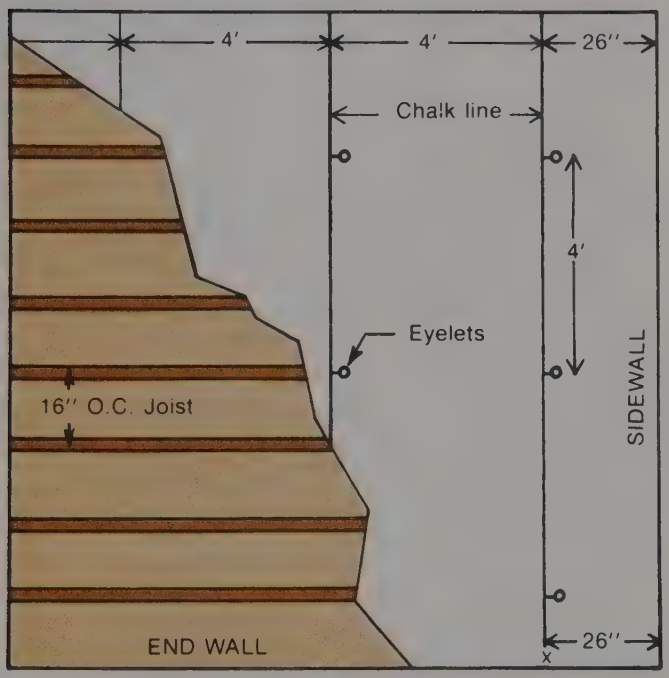
Install the screw eyes along the chalk lines. Start each row of screw eyes from the same wall. Put the first one in the first joist and than install an additional one about every four feet along the chalk line.

When all the screw eyes are in place, cut an equal number of lengths of 12-gauge annealed hanger wire. Each section of wire should be as long as the distance from the screw eye down to the point on the molding where the tiles will rest, plus about 12 inches for wrapping.

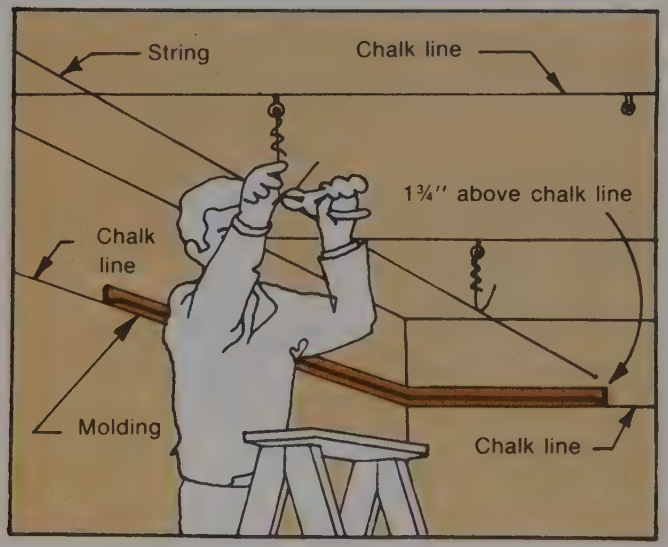
Insert each wire into an eyelet and wrap the short end around the hanging end to hold the wire in place. When all the wires are hung, stretch a string beneath the first



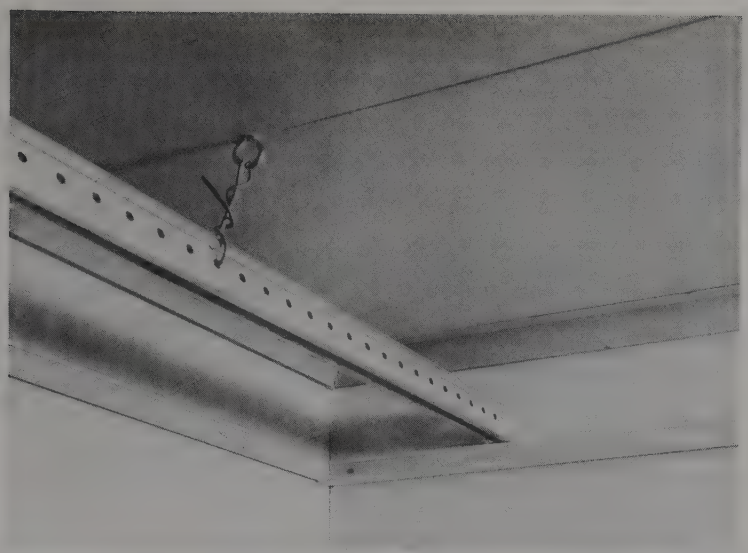
Construct a valence, as shown, when ceiling level is below the top of a window. If there is a stair well, use a similar procedure where the well intersects the ceiling.



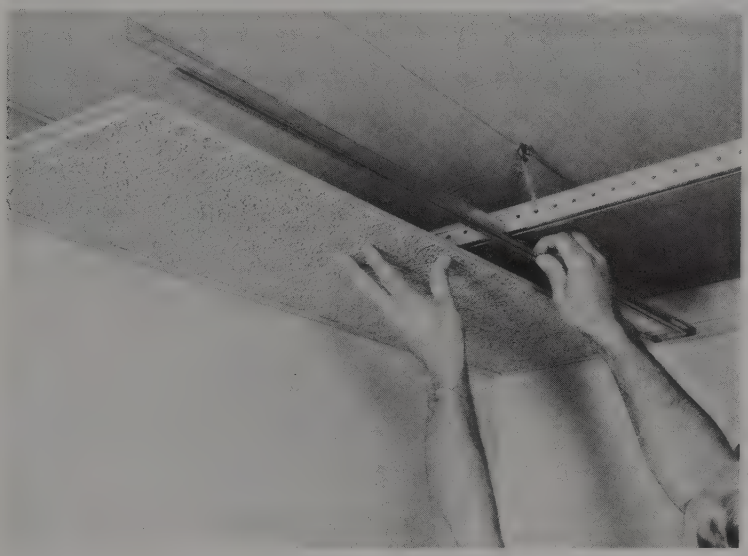
Snap chalk lines across joists to mark locations of main runners. First runner is 26 inches from the wall. The rest of the runners are hung parallel to the first at four-foot intervals. Eyelets are screwed into joists along the chalk lines, with the first of each row in the first joist and rest following about every four feet.



Use a taut line to mark height of main runners. Bend each hanger wire at a sharp right angle where it touches the taut line.



Ceiling tiles and cross tees are installed a row at a time.



Placing the first ceiling tile. Just push it against the wall. Then snap a cross tee onto the main runner and push the tee toward the tile until the cross bar of tee slides into the kerf in the edge of the tile. Note how the long dimension of the tile runs perpendicular to the main runners.

The first main runner in place.

line of screw eyes. The string should be 1¾ inches above the point where the border tiles will rest on the molding. Use pliers to bend a sharp right angle in each hanger wire at the point where it touches the string. When this is done, you are ready to install the first main runner.

Install the runner with the open end toward the wall. Thread each hanger wire through the nearest hole in the runner, bend it up at the right angle and wrap the end around the hanging part. Splice additional sections to the runner to bring it to within one inch of the opposite wall.

When all the runners are hung, begin work on the first row of tile. Each tile is one foot wide and four feet long. They are installed in rows, lengthwise, across the main runners.

The last row of tile must be at least four inches from the wall, so measure the room in the same direction as the main runners. If the distance is an exact number of feet and no inches are left over, the first row will be one tile wide. If there is a remainder of more than four inches, again, use a full tile width for the first row.

If the remainder is less than four inches, then trim the tiles in the first row to a width of four inches. Also, if the starting wall is not straight, use a stretched string as a guide for the edges of the tiles away from the wall. Trim the tiles to fit flush between the wall and the string.

To start the first row, place the first tile in a corner flush to the wall. If the tile is cut, the cut edge goes next to the wall. The long dimension of the tile is perpendicular to the main runners. Snap a cross tee on the main runner and slide it toward the tile, pushing the cross bar of the tee into the kerf along the edge of the tile. That's it. The tile is in place. Keep installing tiles and cross tees until you reach the end of the row. Install a wall spring between the last tile and the wall.

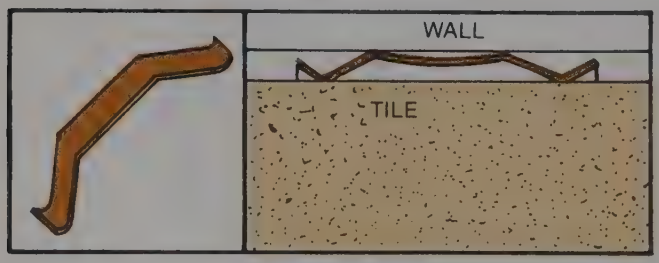
If the last main runner is less than 26 inches from the wall, cut the last cross tee to fit so its end is ¼-inch from the wall. If the last main runner is more than 26 inches from the wall, trim an additional cross tee so that one end fully engages the last cross tee hung from a main runner and the other end is flush to the wall. Use a hacksaw or aviation snips to cut cross tees or main runners.

Trim the last tile in a row so that it is ⅜-inch from the wall and use the remaining piece to start the next row, going back each time so that each row starts from the same wall.

When you get to the last row of tiles, trim them ⅜-inch short of the wall and insert two wall springs between the wall and the edge of the tile. The springs will prevent the tiles from shifting relative position as the house expands and contracts.

The very last tile must be ⅜-inch short of each of the two walls that form the corner. Stick two toothpicks or nails into acoustical holes in the tile and use them as handles as you jockey the tile up through the hole and then work it onto the shoulder of the tee and let it drop into place. Before placing the last tile, put a few drops of white glue on its tongue to hold it permanently in place.

Insert one wall spring between the wall and the last tile at the end of each row and two wall springs between the wall and the long edge of each tile in the last row. The springs keep the tiles from shifting relative position as the house expands and contracts.



See also: ADDITIONS, HOME; HOME IMPROVEMENT.

You can turn or form any of these vessels (shown unfired) without a potters wheel. A simple, inexpensive banding wheel is all that is required.

How to Throw Pottery without a Wheel

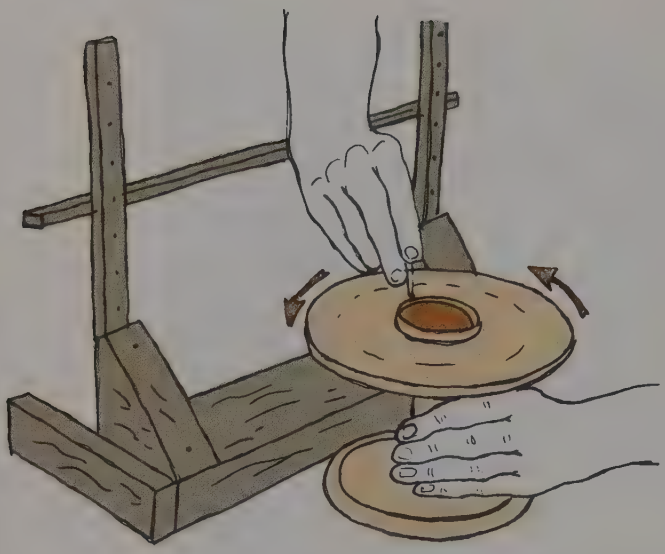
Use a simple hand-turned bench whirler instead of an expensive potters wheel to produce professional-looking clay articles

MOST CERAMICS HOBBYISTS at some time or other want to make lamp bases, bowls, vases, pots and pitchers, and other round or cylindrical pieces. While this type of ceramic work usually requires a potter's wheel—a large piece of equipment and a major investment—well-formed "wheel thrown" pieces can be made on a bench whirler or banding wheel in less than one-half an hour each.

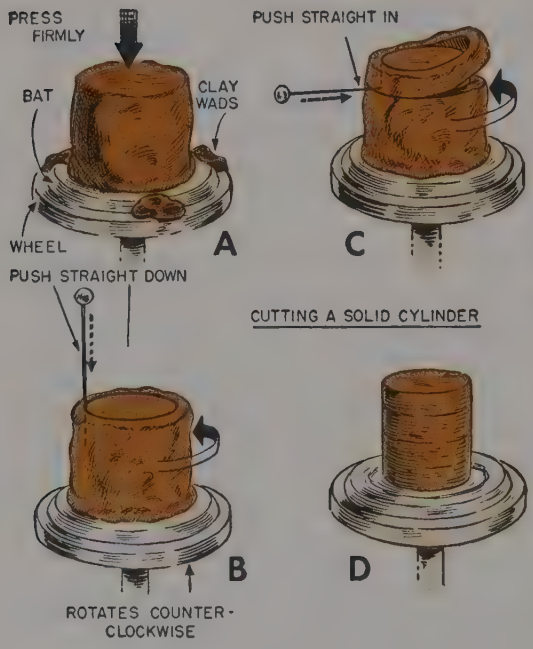
Except for the banding wheel (which can be improvised at home), most tools needed by the ceramist are regular steel-end clay and plaster tools that can be purchased from most ceramics supply stores or mail order houses. An old spoon with the end sharpened can be used to shape inside of a clay piece. Tools can also be made of any thin, flat metal, such as an old hacksaw blade or a clock spring. Shape ends and insert or wire to a wood handle. You will also need plaster bats and a long length of stiff, thin wire (an old hat pin will be fine).

Make the arm rest from scrap wood as shown, nailing pieces securely together. The arm rest is used to give firm support to the right arm yet leave wheel free to turn; however, a pile of books or a large box will do. The wheel turns counterclockwise and shaping of the piece is done at the three o'clock point on the wheel. Any type of clay, purchased at your local ceramics dealer, can be used with the banding wheel —clay to be fired and glazed, or self-hardening and oven-baked clays that need no

ceramic tile: see tile, ceramic
chain saw: see tools
chain saw maintenance: see maintenance, chain saw

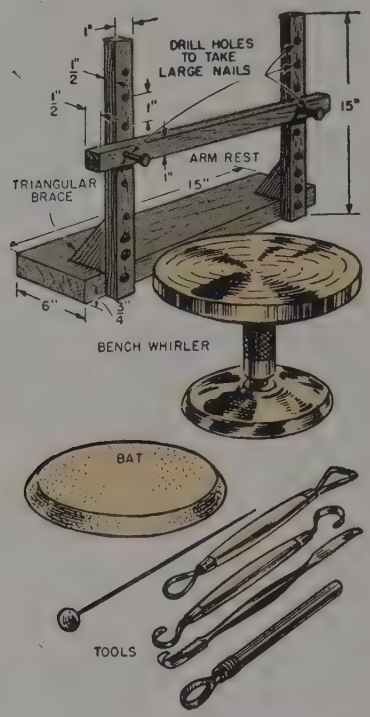


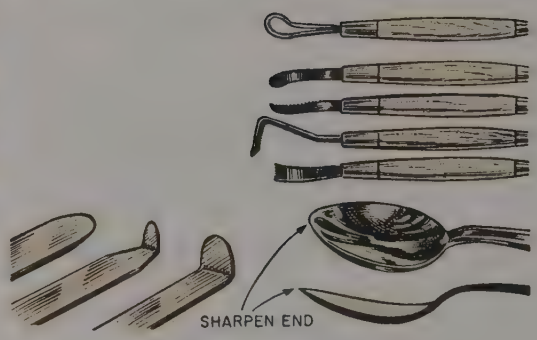
To use the banding wheel, rotate it at an even speed with one hand and work on the piece with your other hand. Build a rest, as shown here, or use a box or a stack of books, to steady your arm.



CUTTING A SOLID CYLINDER

To turn a piece, first form a rough cylinder, place it on a plaster bat and trim it to a perfect cylinder with a stiff straight wire. Potters tip: wet the bat and bottom of the rough cylinder so they will stick together firmly.

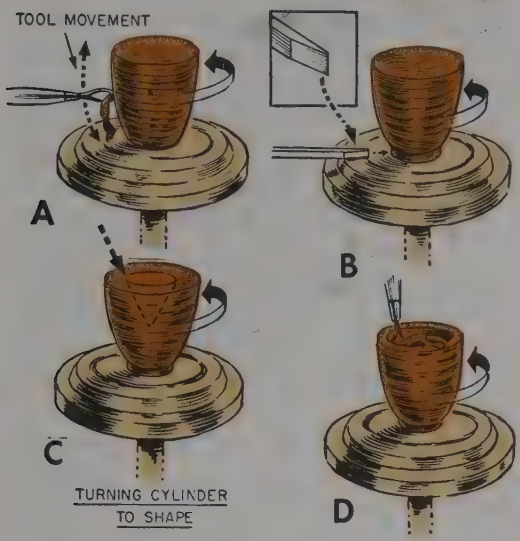




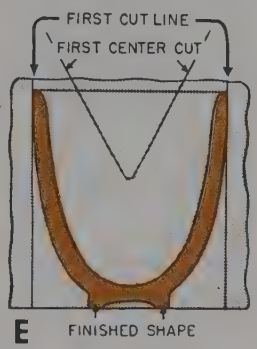
EQUIPMENT YOU WILL NEED

firing and can be decorated with painted-on colors.

There are two basic ways to turn a piece on the banding wheel. The first method is to cut the shape from a solid cylinder. Start with a thoroughly wedged ball of clay that is moist yet not soft enough to sag out of shape. (To *wedge* clay, cut it into two pieces and dash together to expel air bubbles. Repeat several times.) Shape clay to a rough cylinder about ½-inch larger all

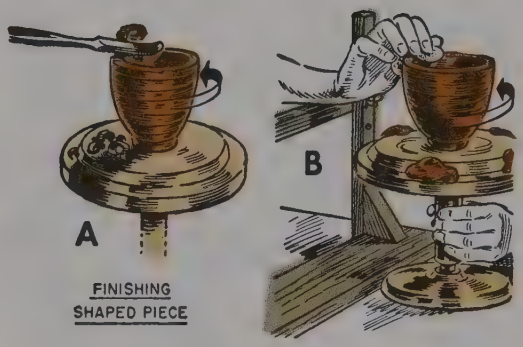


Shape the cylinder to the form you desire by shaving thin slices from it with a wire-loop tool, as in A. Form the base with a wedge-shaped tool cut from a stick of wood. To hollow the piece, first use a stiff wire to cut out a cone, then shave the inside to shape with the wire-loop tool, in the same way as you formed the outside.

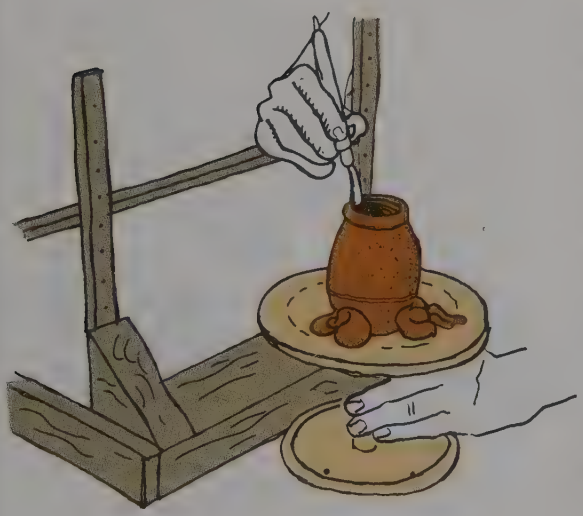


around than piece to be made. It would be wise to make up a rough sketch of the piece to be made before starting work. Attach plaster bat to wheel with wads of moist clay, then press prepared cylinder firmly down onto plaster bat, as near to center as possible. Wet plaster bat and bottom of clay cylinder for good adhesion.

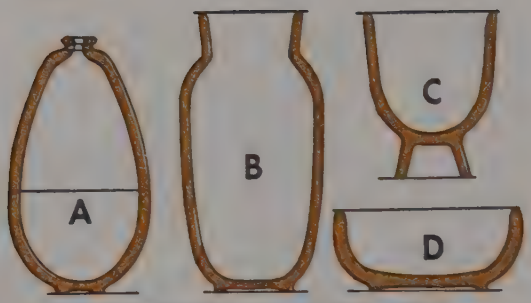
Raise arm rest bar to convenient height, start wheel turning slowly with left hand, then, using stiff wire, brace right arm against arm rest and bring wire straight down into clay about 1 to 1½ inches. Revolving wheel will cause wire to cut perfect circle to diameter desired. Lift out wire and push straight in to side of cylinder far enough to reach first cut. Lift off waste clay. Repeat these steps until you have a perfect cylinder.



To finish the piece, shape the top with a metal tool, turning the wheel relatively slowly. Then smooth it all over with a wet elephant-ear sponge.



Piece may be worked again when it is leather hard. Use wads of soft clay to hold it to the bat.



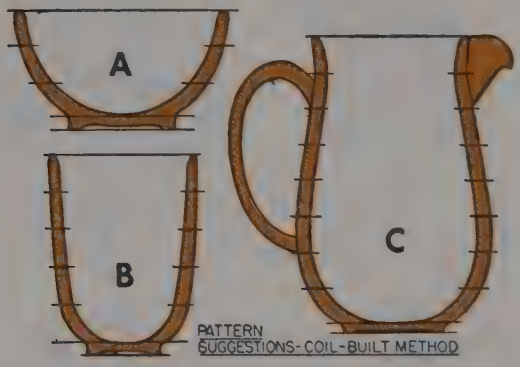
PATTERN SUGGESTIONS - SOLID CYLINDER METHOD

Shapes like these may be turned from a solid. Shape A is actually two pieces that were turned separately, then joined with slip at the horizontal line.

Now, using one of the wire end or metal tools, turn or cut cylinder to required shape. Brace right arm firmly, spin wheel faster (from 30 to 80 rpm) and cut thin layers of clay from cylinder. Just guess at all speeds mentioned—spin wheel fast enough to allow you to "control" the clay. Only experience will enable you to gauge the proper speeds to turn the wheel during various steps of shaping. Move tool point up and down, cutting thin slices and slowly "turning" cylinder to required shape. Keep wheel revolving steadily. Adjust height of arm rest as needed to allow free movement of tool without cramping.

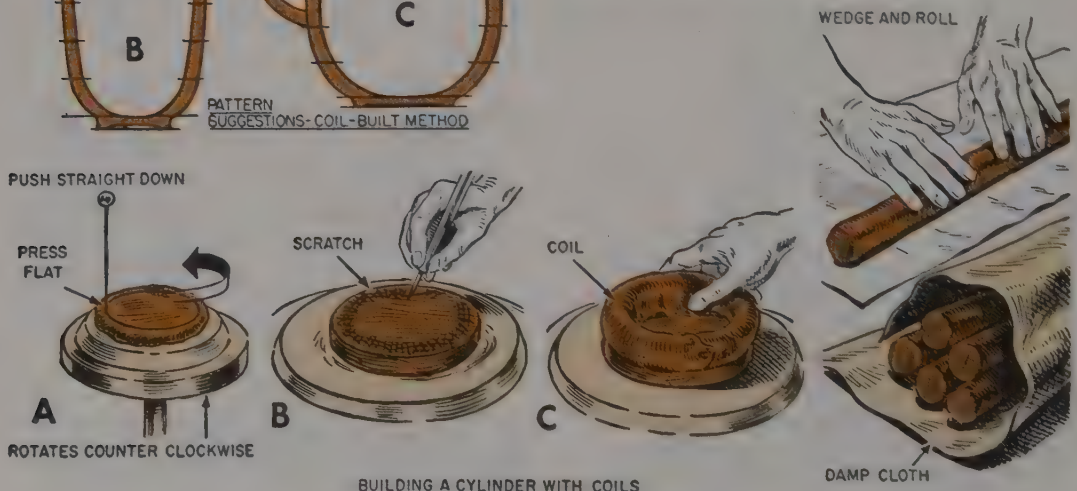
Shape base of piece with a short length of wood, sharpened to a wedge shape. Push this tool straight into base, then round off base from foot to side walls with the wire end or metal tool.

Now shape the inside of the piece. Cut a cone-shaped wedge from center with the stiff wire, then, using the wire end or metal tool, carefully shape inside of piece, cutting thin slices of clay until inside is perfectly shaped with round bottom and walls of even thickness. Illustration shows a good shape to start with; note the relation of finished shape to rough cylinder and preliminary cuts.



PATTERN SUGGESTIONS - COIL-BUILT METHOD

Start forming a piece with coils by putting a flat slab of clay on a bat and trimming it to a disk. Scratch a border around it to form a bond with the first coil. Then form the coil into a ring on the base, as shown in C.

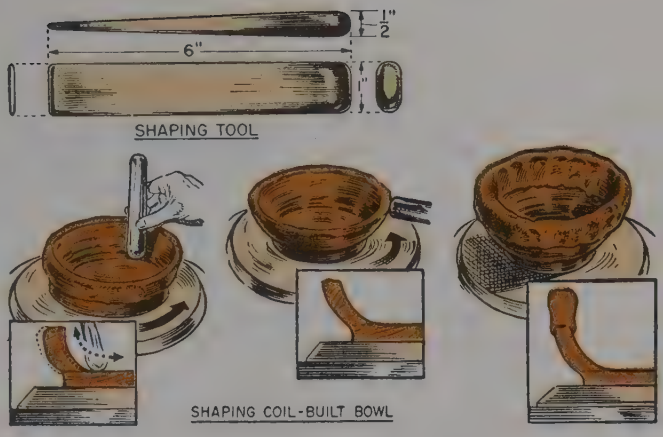


BUILDING A CYLINDER WITH COILS

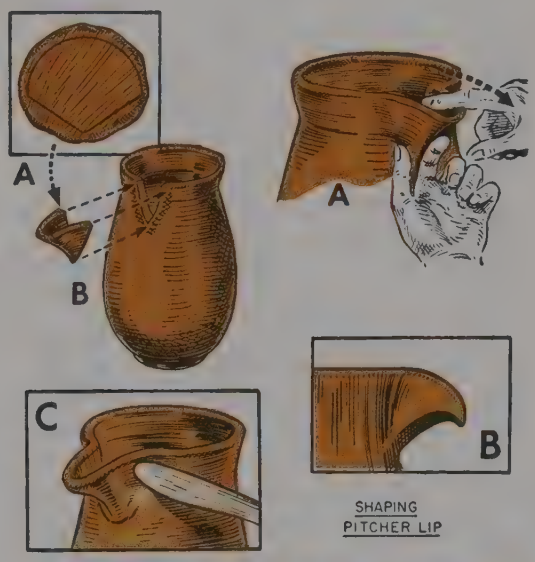
Level top of piece by scraping with metal tool, held firmly while wheel is revolved at half the speed used for shaping. Smooth surface both inside and out by holding a wet "elephant ear" sponge (a fine-grained soft sponge used for finishing) firmly against piece as wheel is revolved rapidly.

Remove plaster bat, with shaped piece attached, from wheel and set aside to dry to leather-hard condition. The piece will then come free of the plaster. Again attach plaster bat to wheel and place shaped piece upside down on bat. Center on wheel by applying light pressure with fingertips while turning wheel slowly. Anchor firmly with wads of moist, soft clay, which can be easily removed when base has been completed. Brace arm firmly and cut shape of foot or base into piece on wheel.

Now try another shape. The closed shape is made in two parts. First turn the lower part up to the horizontal line near



▲ *You can make your own shaping tool of boxwood, or other hard, fine-grained wood. Be sure to polish it with oil. Use the tool to form each coil as shown, then add the next coil.*



➤ *How to make the handle and spout of a pitcher. When making the spout, cut a pattern out of a piece of paper and try it on the pitcher. If it fits, use the pattern to cut a piece of flattened clay to the same shape.*

the center, shape inside and turn foot. Turn top of piece separately, neck of shape down, and fasten with slip (liquid clay) to first piece when both are leather-hard. When joint has set up leather-hard, turn neck of shape with metal tool and trim down joining. This shape is suitable for a lamp base. (Cut holes for wiring before clay dries.)

The second method for turning with the banding wheel uses a softer clay. Attach bat to wheel and press a one inch thick disc of soft clay to center of bat. Then cut a perfect circle in the clay with the stiff wire.

Prepare a few coils or rolls of soft clay, well wedged, each about one inch in diameter and long enough to go completely around the clay disc. Keep coils in damp cloth until ready to use. Clay should be moist enough to bend easily into a circle without cracking. Scratch disc of clay on wheel, brush with thick slip and press a coil of clay firmly onto rim. Press firmly together with thumbs, working edge of coil into clay disc.

Make a shaping tool from a ½ x 1 x 6-inch scrap of boxwood or other fine-grained wood and sand as smoothly as possible. Finish by polishing with a cloth soaked in oil.

Now spin wheel counterclockwise at from 80 to 100 rpm. Bracing arm firmly, place large end of tool against inside wall of the clay coil and, with firm, steady pressure, press wall out and up to required shape. Keep wheel spinning at an even speed. Move tool in an arc. Reverse tool, using thinner, lighter end to shape outside of piece.

Weld second coil firmly in place on top of first shaped coil and continue shaping of piece, first inside, then outside. Keep shaping and adding coils until shape is completed. As coils are added, raise the arm rest.

This method of wheel building and shaping from coils is ideally suited for making tall, closed shapes like the lamp base, as the inside is finished as work progresses. Clean up the inside with a light sponging; finish outside by lightly turning with the wire end tool, and sponge off. Turn the foot as shown.

To make a pitcher, first turn basic shape, then attach pouring lip or spout. Try a paper pattern of lip for fit and shape, then cut lip from a flat pad of moist clay the same thickness as the walls of the pitcher. Cut opening to fit lip in pitcher body and roughen edges of opening. Smear thick slip over roughened area and press lip firmly in position. Use a modeling tool to weld lip firmly in place, smooth both inside and out so that lip "fairs-in" smoothly to pitcher body.

To make a non-drip lip, moisten forefinger and smoothly draw it across end of lip with a sweeping downward motion, supporting spout with left hand. Do this a few times until lip has thin edge.

Shape the pitcher handle from a coil of clay. Press coil flat and bend to handle shape. Set aside until both handle and pitcher are stiff enough to handle without sagging out of shape. Score pitcher at points handle will be fastened, brush on slip and press handle firmly in place. Use modeling tool to weld handle firmly to pitcher. Either model handle to run smoothly into pitcher body or model a decorative joining.

With practice, your skill will rapidly develop and you will soon be able to make many different cylindrical shapes on the banding wheel. The baked or fired pieces you make can be glazed or left undecorated.

WHERE TO FIND IT

The banding wheel can be purchased from Craftools, Inc., 396 Broadway, New York, N. Y. 10013.

Build a Sun-sauna Chaise

This chaise lets in the sun's warmth, keeps out the wind with an adjustable fiberglass canopy

THE SUN-SAUNA CHAISE is a device with a revolving cover made of corrugated fiberglass. This lets in the dry heat of the sun, yet keeps out the wind. As the season becomes cooler, you need only lower the top further to retain more heat.

Although the sauna will heat up in a very short time when it is closed and in direct sun, there is plenty of air to breathe. However, if you desire greater ventilation, or children may use the chaise, you should cut a number of air vents in each of the circular ends.

As an added benefit, the fiberglass cover protects the lounge pad from sun, rain, and dust when the unit is not in use. As construction is of plywood and other easily obtained materials, it is an easy project for anyone of average ability with tools.

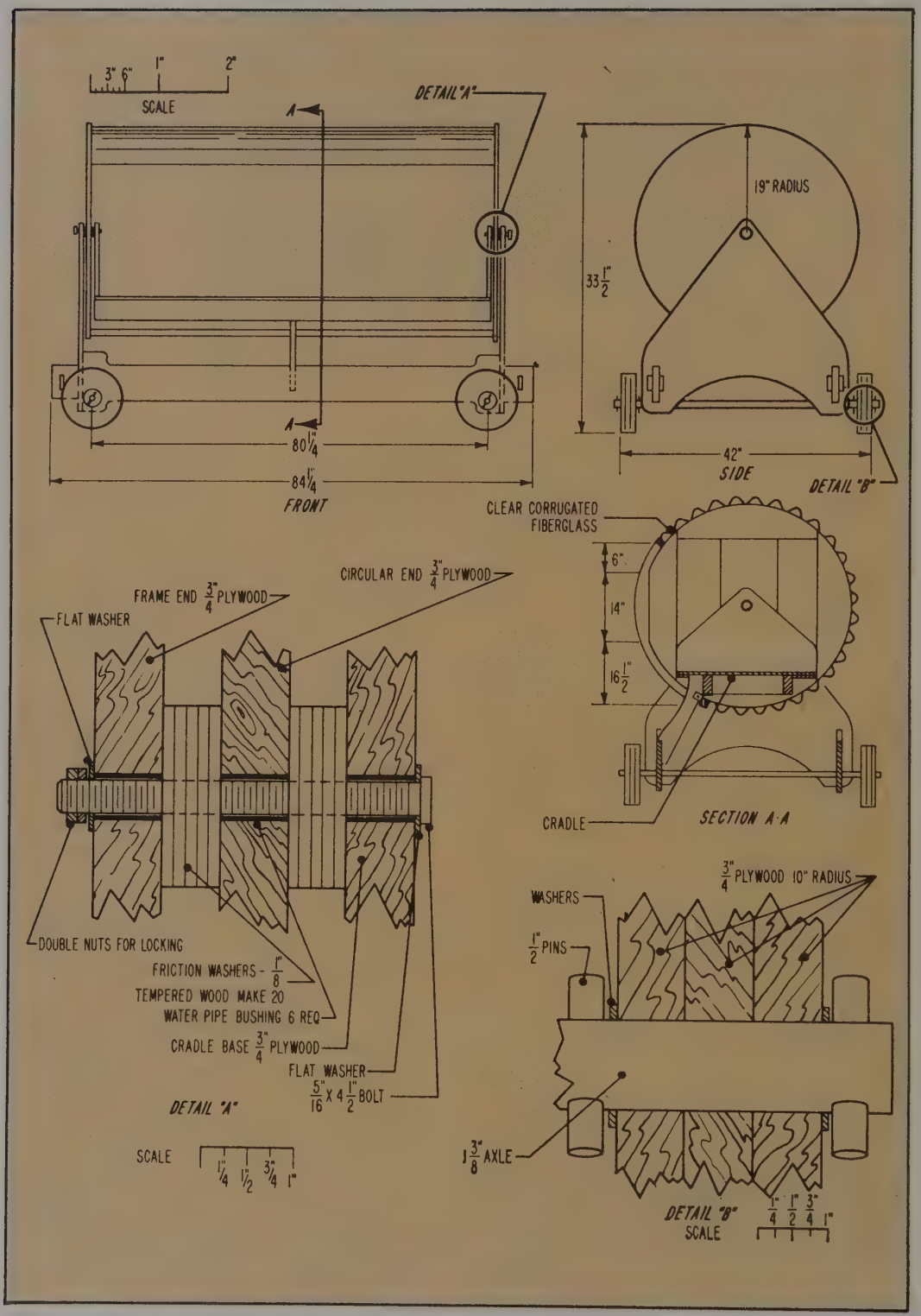
Three major assemblies make up the chaise: frame, cradle, and cover. Trace the frame parts on ¾-inch plywood, and cut these out. Cut out the notches in the two end pieces through which the side pieces will be slipped, and cut out the notches in the sides pieces that will take the locking wedges. Drill a hole at the top of each end piece slightly smaller than the water pipe bushing to be used. Drive a bushing in each hole with a hammer, very carefully. Drill holes in the side pieces for the axles, then assemble the frame. Do not install the locking wedges at this time.

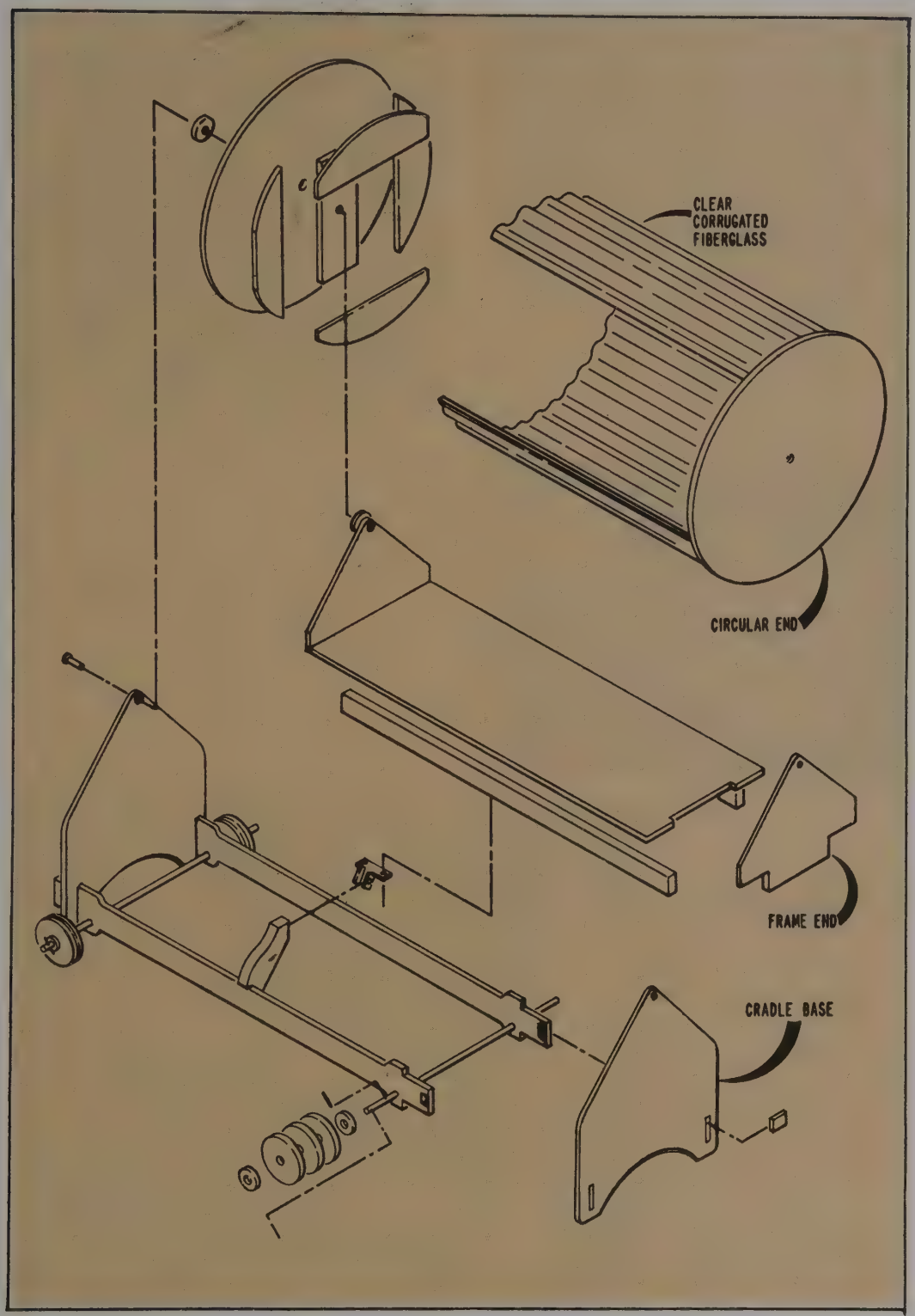
Before assembly, it is advisable to clamp together matching pieces such as the two frame ends for final trim and sanding in order to have an exact match.

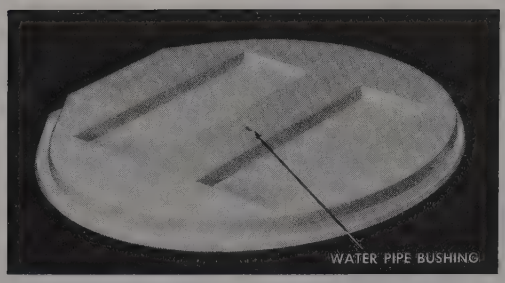
Make up the four wheels. Each is a lamination of three thicknesses of ¾-inch plywood, cut to a 9½-inch diameter. Glue and nail the discs together, and sand smooth. Tempered hardboard axle washers are made up, or their equivalent may be purchased at a hardware store.

The two axles are cut from 1⅜-inch closet rod stock. Two ½-inch holes are drilled in each end of each axle. Slide an axle through its holes in the frame side

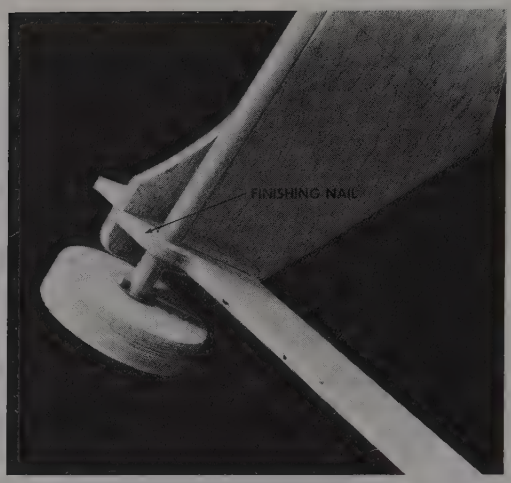
cheese board: see plastics, fabricating
chessboard: see game boards
child's boat: see raft
child's furniture: see furniture, children's
chimes: see doorbell, chimes


3" 6" 1" 2"
SCALE
DETAIL "A"
A
A
80 1/4"
84 1/4"
FRONT
19" RADIUS
33 1/2"
42"
SIDE
DETAIL "B"
CLEAR CORRUGATED FIBERGLASS
6"
14"
16 1/2"
CRADLE
SECTION A-A
FRAME END 3/4" PLYWOOD
CIRCULAR END 3/4" PLYWOOD
FLAT WASHER
DOUBLE NUTS FOR LOCKING
FRICTION WASHERS - 1/8"
TEMPERED WOOD MAKE 20
WATER PIPE BUSHING 6 REQ
CRADLE BASE 3/4" PLYWOOD
FLAT WASHER
5/16" X 4 1/2" BOLT
DETAIL "A"
SCALE
1/4" 1/2" 3/4" 1"
3/4" PLYWOOD 10" RADIUS
WASHERS
1/2" PINS
1 3/8" AXLE
DETAIL "B"
SCALE
1/4" 1/2" 3/4" 1"

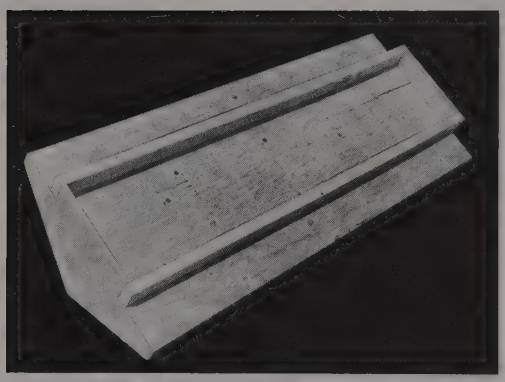

CLEAR
CORRUGATED
FIBERGLASS
CIRCULAR END
FRAME END
CRADLE BASE



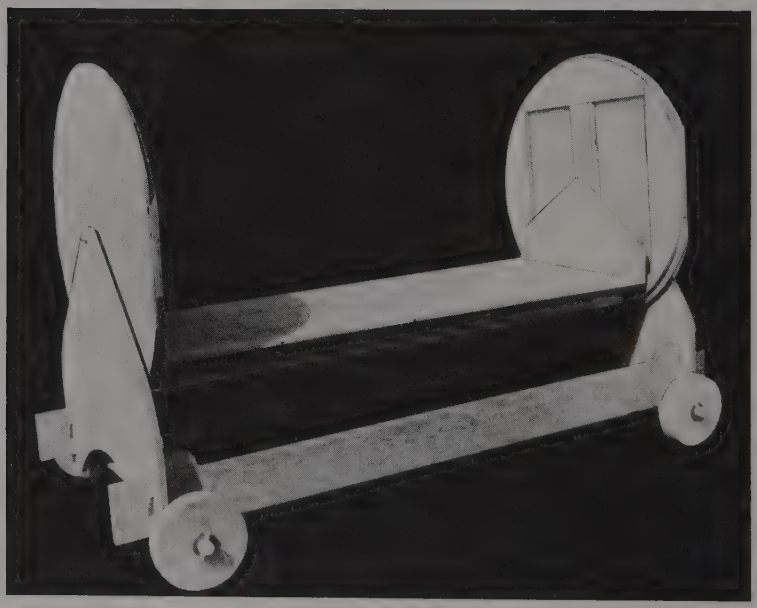
Circular end shown assembled. Use exterior type wood glue and #8 x 1-in. flat head wood screws to assemble.



As shown here the axle is secured in the hole through the tie rail with the aid of #8d finishing nails.



Pictured here is the assembled cradle looking at the underside. You can assemble with glue, finishing nails.



After assembling the supporting frame, circular ends and cradle, you're ready to paint and decorate sauna.

pieces, then tap a ½-inch dowel peg through the hole closest to each side piece. Add a washer, wheel, and washer in that sequence at each end of the axle, then tap ½-inch dowel pegs through the outer holes. Repeat this with the second axle. An 8d finishing nail driven through the side piece into the axle will prevent it from shifting.

Now make up the end pieces for the cover. The large circle piece of each assembly is ⅜-inch plywood; the other parts are all ¾-inch plywood. Put a thin coat of glue on mating surfaces, and assemble with #8 1-inch flat head wood screws. Drill through the center of each assembly and tap in a water pipe bushing.

Now make up the cradle. Its ends and bottom panel are plywood, and it is stiffened and strengthened with two lengths of 2 x 4-inch hardwood stringers—common fir is just fine. Drill a hole near the top of each triangular end panel, and tap a water pipe bushing into place. Use glue on mating surfaces, then assemble the cradle with finishing nails.

Cut out twenty friction washers from ⅛-inch tempered hardboard. Insert a 5/16 x 4½-inch bolt through a flat washer, then the inside face of a cradle end, five friction washers, the inside face of a cover end piece, five more tempered hardboard friction washers, then the inside face of a frame end. Add a flat washer and double nuts to lock the bolt in place. Repeat at the other end of the chaise.

At this point you can add the locking wedges in the ends of the two frame side pieces, and install the cradle brace. Finish with at least two coats of a good exterior grade paint, sanding lightly between coats.

The cover itself is made up of four six-foot lengths of corrugated fiberglass. Predrill the holes for nails at each end, and fasten to the end pieces with 1¾-inch galvanized common nails. Use ⅜-inch O.D. flat washers under nail heads; note that nails go through the "high" parts of the corrugations, not the low parts. Lap each sheet at least one corrugation over the adjacent sheet.

Finally, add molding strips and handles on the exposed edges of the fiberglass panels. The handles go on the inside, of course. Put a colorful vinyl-covered mattress on the cradle bed, and roll the chaise out to your yard or patio.

Original design by Steve Ellingson.

See also: FURNITURE, OUTDOOR; POWER TOOLS; HAND TOOLS.

MATERIALS LIST

Quantity	Size and Description	Purpose
1	¾" 4'x8' plywood	frame, cradle, and cover ends
1	¾" 2'x8' plywood	frame and wheels
1	⅜" 4'x8' plywood	cradle bed
1	⅜" 2½'x5' plywood	cover ends
2	2" 4"x6' fir	cradle
1	1⅜"x8' closet rod	axles
2	26"x12' clear fiberglass with 2½" corrugations	cover
1	½" O.D.x 7" metal water pipe	bushings
2	5/16"x4½" hex head bolts	

NOTE: Also need, nuts, washers, molding strips, handles, exterior paint and chaise pad.

Enjoy a Two-place Chaise

This solid, well padded piece of outdoor furniture is built of heavy lumber

ON A PATIO, under a shade awning, or on a covered deck over the garage, you'll find this solidly built two-place chaise to be a most comfortable piece of furniture. It has many favorable features, including the well-padded upholstery supported by woven rope, and the large wood wheels which make it easy to move the unit to a desired location.

This is an interesting home workshop project. The parts are made mostly of rugged two-inch thick lumber, such as 2 x 4, 2 x 6, and 2 x 8. Note that these lumber sizes designate the rough stock as cut at the mill. When dressed down to the material you purchase at the lumber dealer, the two-inch thickness has been reduced to an actual 1⅝ inches. A 2 x 8 board, for example, will be 1⅝ x 7½ inches in dimension. Keep this in mind when you work on any project. All experienced shopworkers automatically translate the stated size to the actual dimension, which occasionally varies by as much as ⅛-inch.

Proceed with the chaise construction in this order:

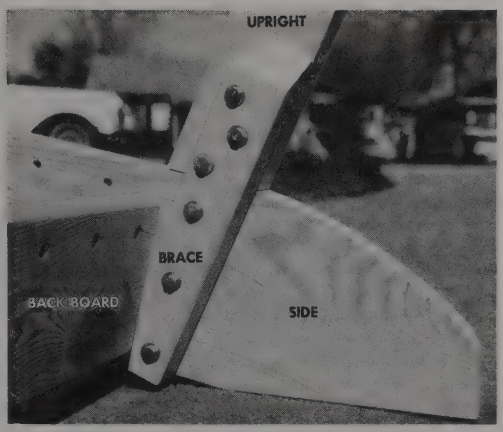
Cut the two side pieces from 2 x 8 stock, each piece 32⅜ inches long and shaped as shown in the sketch by tracing the outline on one-inch squares. Cut the front board to 7⅜ x 45¼-inch size from 2 x 8 stock. Cut the back board to a 42-inch length from 2 x 6 stock.

Make the two upright parts for the back from 2 x 4 stock, each 24 inches long. The single top bar is also from 2 x 4 stock and 42 inches long. Shape a pair of braces as shown, using 2 x 4 stock 13 inches long. The square end of each brace is sharply beveled to reduce its bulky appearance.

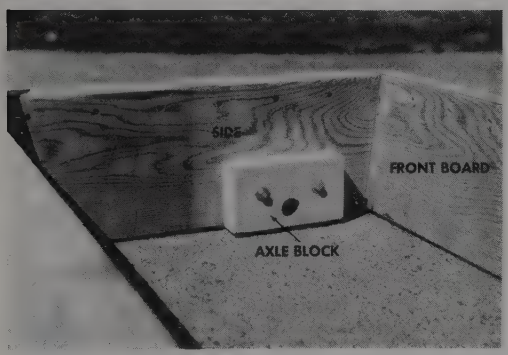
These are the basic parts for the chaise, but there is an important detail to perform at this juncture.

The chaise cushions are supported by a net formed by weaving sisal rope through holes in the chaise frame. You'll find it much easier to drill these holes before the parts are assembled, particularly if you have a

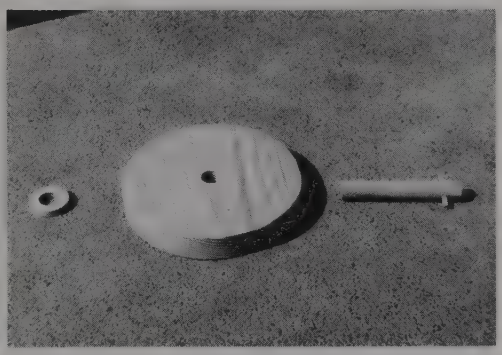
▲ *Closeup of frame assembly corner. Backboard and upright are supported by brace attached to side member with 3-in. lag screws.*



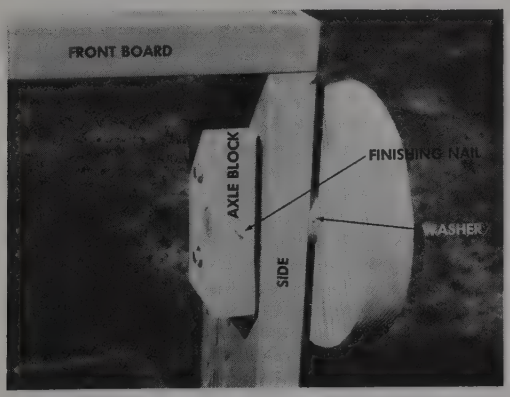
▲ *Another view of corner assembly. Note the 45° bevel at top end of brace and how lag screws are spaced to bypass screws in side.*



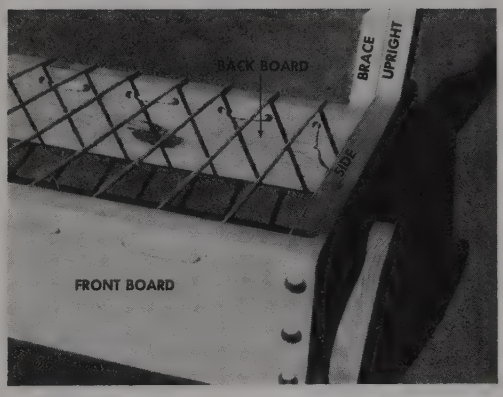
▲ *Axle block, drilled for 1 in. dowel, is attached to the sides near front board. The 3-in. lag screws provide plenty of support.*



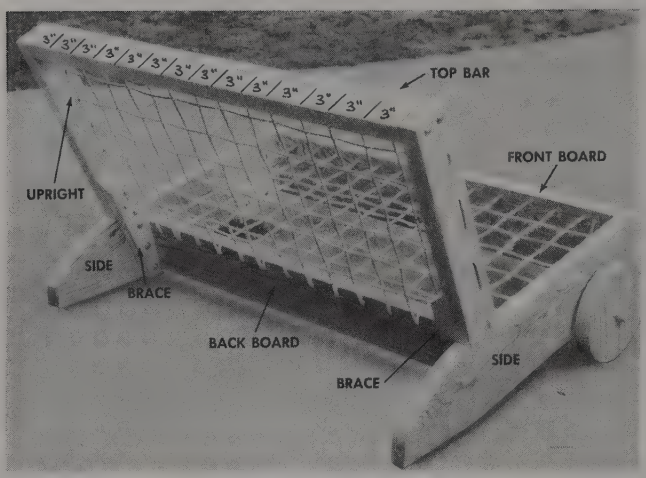
▲ *The 9 1/4-in. diameter wheel is cut from a piece of 2x10 in. stock. Wood washer slips over dowel axle fitted with 1/4-in. end pin.*



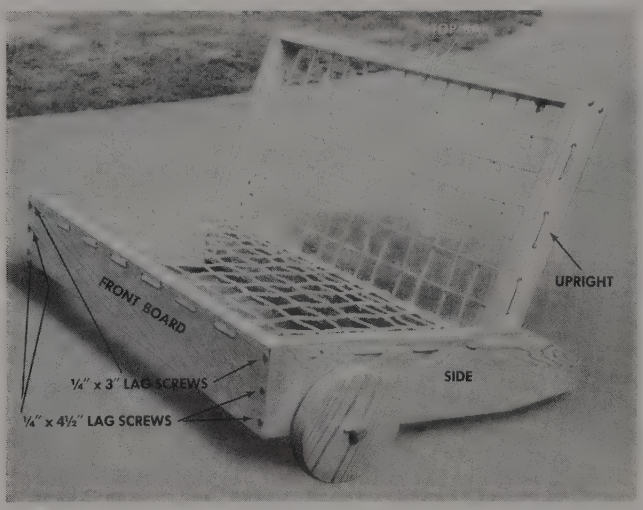
▲ *Completed wheel assembly showing how the dowel axle is locked in place by means of a finishing nail hammered into the axle block.*



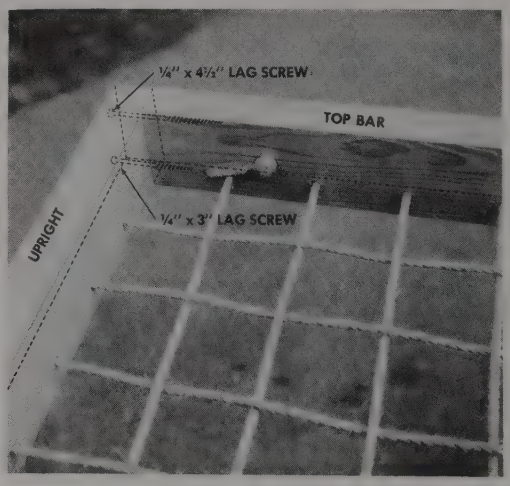
▲ *Rope threading started through the front and back boards. Note how rope goes through front board holes but over top of back board.*



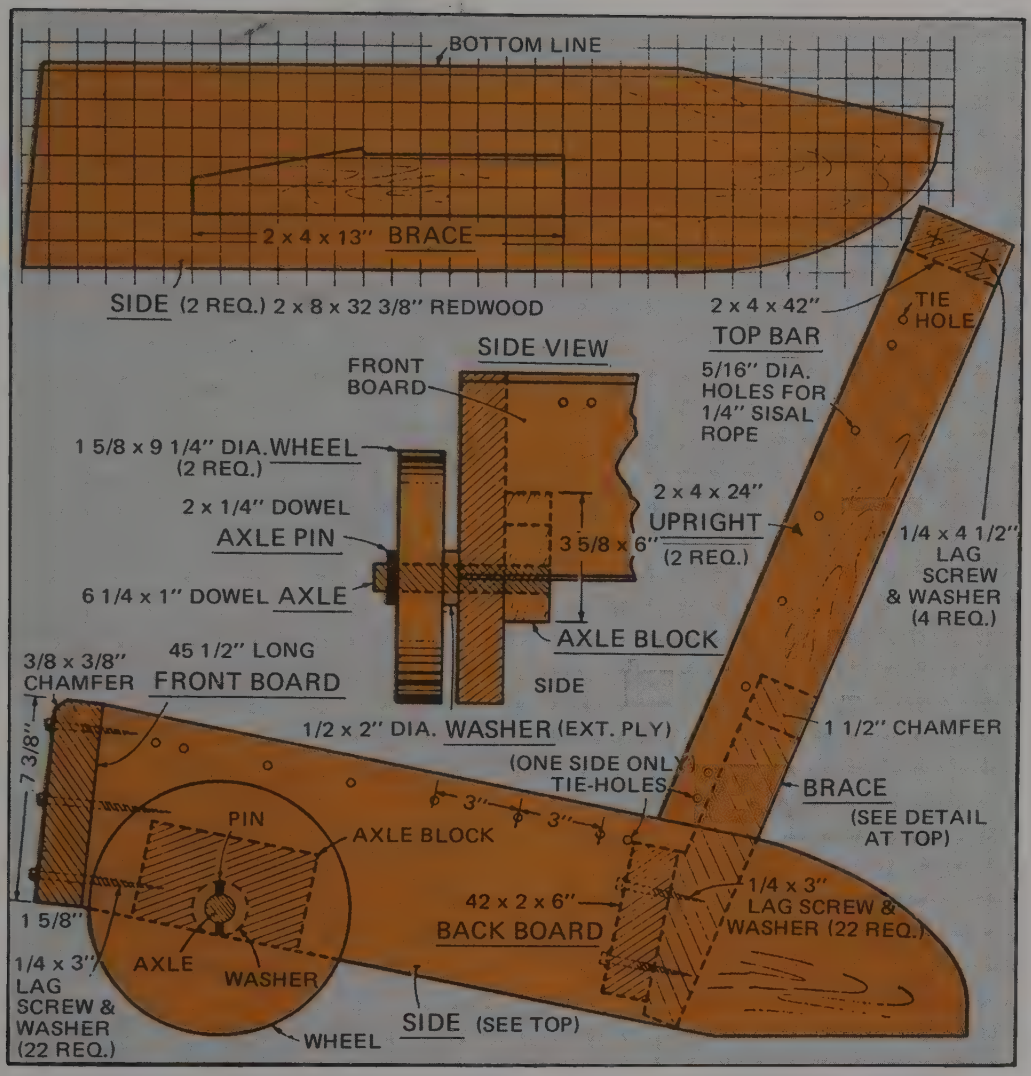
Rear view of completed assembly. Back and bottom weaves go through same holes in the back board. See text for size and details.



Three-quarter front view of completed assembly. Note neatness of rope threading in side and front boards, and wheel location.



Rope end is knotted, pulled taut, then anchored to top bar with a nail. Whenever necessary, rope can easily be retightened.



drill press. Holes are placed three inches apart. In the front board they start 4⅝ inches from each end, and one inch below the top edge.

The holes in the front board and top bar are 5/16-inch in diameter, but in the back board the rope is threaded twice through the same holes, so the holes must be drilled to ½-inch in diameter. Holes in the sides are 5/16-inch diameter, and there are two "repeats" on each of the sides as seen in the photograph. It is possible to assemble the entire chaise and drill the holes later, using a template to space the intervals, if you prefer to do it that way.

Attach the front board to the two sides with two 4½-inch lag screws on the lower part and one three-inch lag screw at the upper end, using predrilled pilot holes of sufficient diameter to avoid splitting the wood. Chamfer the top edge of this front board, along its entire length, to a radius of ⅜-inch, as shown in plan. The chamfering is easily done with a block plane, but you'll get a neater result with a shaper bit used in a router. The purpose is to avoid a sharp

corner at the edge of the seat. Use a washer with each lag screw so the screwboard won't dig into the wood. For outdoors, to avoid rusting, it is better to use bronze lag screws and washers.

Attach the braces to the sides in the position shown, using three lag screws, 3 inches in length. Then assemble the back board and the vertical members. Drill the back board for the two lag screws at positions which will by-pass the original screws going into the sides.

The axle blocks are pieces of 2 x 4, cut to a 6-inch length. Drill one-inch holes for the dowel axle in each block at uniform positions, and attach the blocks to the sides with two 3-inch lag screws through pilot holes. Cut the one-inch dowel in half to form two axles, one for each wheel. Drill each axle for a ¼-inch dowel pin. Make the 9¼-inch diameter wheels, and also plywood washers which will fit over the axles between the wheel and the chaise sides. The wheel assembly is put into the axle block, and a finishing nail is driven to lock the axle in position.

Weaving the rope net is the next step. Do the bottom first. The rope goes through the holes, in and out, of the front board, but it goes over the top edge of the back board and down through the hole for the return. Start by tying a knot in the end of the rope, then put the rope through a hole in the back board, up over the top edge to the front, then out the next hole to go over the top edge of the back board again and down into the hole underneath.

When the threading is done, tie a knot at the end, pull the rope tightly to get tension, and nail down the end into the back board through the knot. In that way, it will be easy to free the knotted end whenever it is desired to pull up the rope so the weave will be made taut again.

The rest follows the procedure illustrated in the photographs, until the bottom and the chaise back are cross-weaved, as tightly as possible.

The rest of the job is a matter of getting the cushion pads, each 22 x 46 or 48 inches filled with cotton batting or foam rubber granules. If your wife is as skilled as you are, she'll have fun making the cushions of a colorful fabric, preferably the waterproof type. A valuable extra will be a polyvinyl slipcover which will protect the chaise if left out in the open.

Original design by Steve Ellingson.

See also: FURNITURE, OUTDOOR; LUMBER.

MATERIALS LIST

Quantity	Size and Description	Purpose
1	2″ 10″x2′ redwood	wheels
1	2″ 8″x10′ rugged lumber	front board and sides
1	2″ 6″x4′ rugged lumber	back board
1	2″ 4″x12′ rugged lumber	uprights, braces, top bar and axle blocks
1	1″x13″ dowel	axles
1	1/4″x4″ dowel	axle pins
8	1/4x4 1/2″ lag screws and flat washers	
22	1/4x3″ lag screws and washers	
200 feet	1/4″ sisal rope	

NOTE: Also need, chaise pads and wood finish.

How to Maintain Your Chimney

Keeping your chimney in good repair will cut fuel bills, keep your house cleaner

A GOOD DRAFT is essential for clean, efficient operation of your heating plant. Better heating, therefore, starts at the chimney where accumulated soot in the smokepipe or flue can prevent proper functioning of your furnace. When neglected for a period of years, as often happens, sufficient soot can pile up in the ash pit at the bottom of the chimney to restrict the draft.

Aside from the considerable waste of fuel and failure to provide sufficient heat, a blocked flue means dirty operation of the furnace and subsequent blowing of fly ash throughout the house, with the resultant soiling of upholstered furniture, draperies and ceilings.

Another cause of heating plant failure is an air leak in either the metal smokepipe, which connects the furnace to the flue, or in the chimney itself because of crumbling mortar in the brickwork. Tiny holes in the smokepipe are easily plugged with POP rivets, which are peened by means of special pliers. Pipes with larger holes, rips in the metal, or bent edges that prevent tight fitting of the pipe sections, should be replaced as such repairs are difficult and seldom satisfactory.

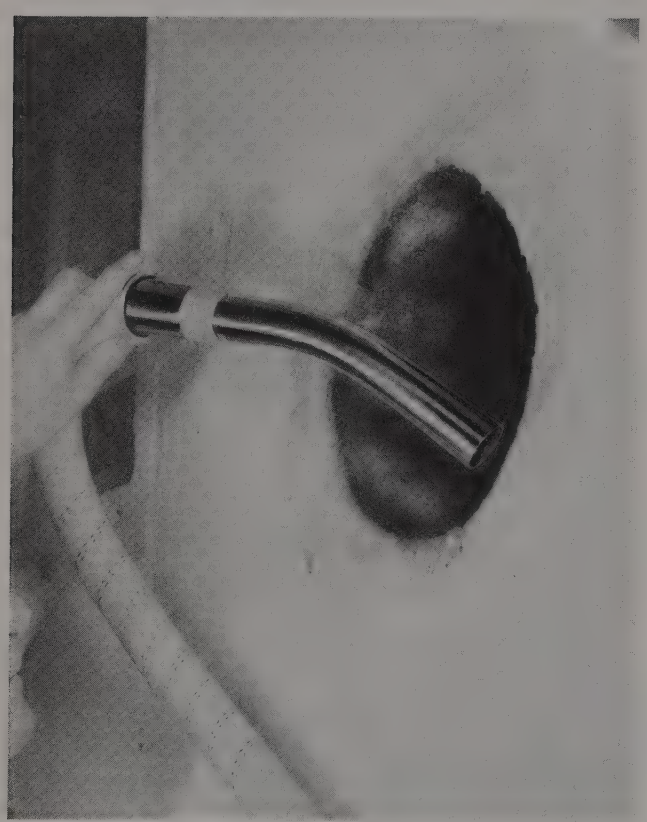
Caulking of the joint where the wall siding meets the chimney is an essential routine of home maintenance. The chimney stands on its own foundation, separately from that of the house itself, so there is a differential in expansion and contraction movements. The elasticity of modern caulking compounds provides some latitude to keep the seal, but the compound tends in time to split or separate from the chimney, leaving an open gap. Removal of the old compound is recommended to provide direct adhesion for the new caulking, although it is permissible to apply a new bead of compound over the old if it is securely bonded to the brick and the siding.

Another location that may require attention is the chimney pot, at the top of the chimney, which seals the ends of the clay flue. A very long ladder is usually necessary to reach that position. Damage to the cement seal is quite rare and would occur

only as a result of an exceptionally heavy storm. At any rate, chimney pot inspection should be kept in mind whenever it is necessary to climb to the roof.

Cleaning the chimney. Do-it-yourself furnace cleaning is not a difficult job, though certainly it's a dirty one that must be followed by an immediate shower. It involves use of a vacuum cleaner, preferably the workshop type with a large five-gallon tank. You will also need a long-handled brush with stiff wire bristles. Wear your oldest clothes, including some form of cap, wrap a scarf or old towel tightly around the neck, tape a gauze pad over the nostrils to minimize inhaling fine soot.

Cleaning can be done at any time of the year, but is best after the heating season, thus eliminating soot that absorbs moisture and causes rusting. Be sure to switch off the burner.



Complete cleaning is done from both ends of the chimney—from the top by dropping a weighted sack down the chimney to dislodge soot from the walls of the flue, and from the ash pit at the bottom, through the cleanout door and by temporarily removing the smokepipe from the furnace connection. If the condition is not extreme, you might skip climbing a ladder to the top. Usually, just vacuuming the ash pit and smokepipe opening will be sufficient.

Loosen the smokepipe by rocking it side-to-side until the cement joint is broken, then separate the pipe sections. Avoid denting the flange edges so that the pipe can be replaced easily.

With the vacuum nozzle, pick up all loose soot around the chimney opening. Extend the brush into the flue as far as the handle will reach, dropping the soot into the ash pit. Finally, use the vacuum to completely clean out the ash pit. If there is a considerable amount of soot, you may have to empty the vacuum tank before the job is completed.

When replacing the smokepipe, examine it carefully for rust holes and repair or replace it if necessary. Make sure the pipe is properly assembled, the joints tightly fitted, then seal the joint at the chimney opening with asbestos cement mixed with water to a thick paste, applied like cement mortar.

The chimney itself should be inspected at least annually for any loose mortar between the brick. Rake out all loose mortar from the brick joint. Pointing the joints is done with a striking tool, a narrow steel bar used to pack the mortar deeply into the open space. R.T.

See also: BRICKWORK; CONCRETE; HEATING SYSTEMS, HOME.

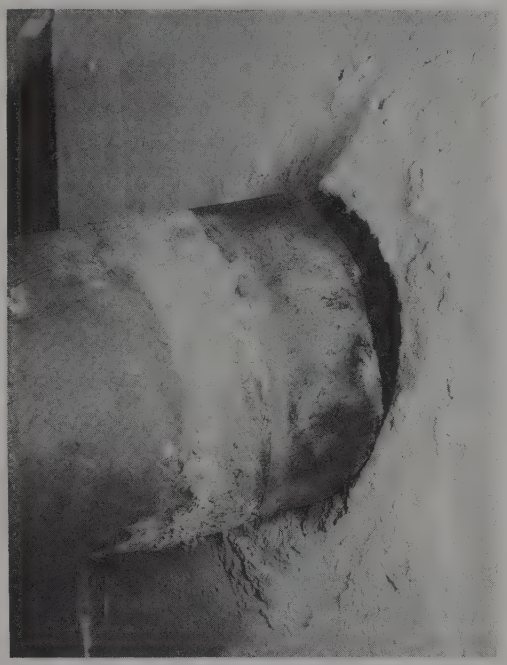
Accumulated soot in the chimney ash pit may affect heating plant efficiency by restricting the draft, resulting in incomplete combustion and excessive fly ash throughout the house.

▲ *Cleanout door at bottom on chimney permits easy cleaning with vacuum hose. Use stiff bristle brush to clear sides of flue. The chore is dirty but not difficult.*

▲ *Joint at house siding to chimney requires periodic caulking to close gap that results from separate foundation of house and the chimney footing.*

➤ *Mortar pointing seals small openings that affect chimney draft. Use striking tool to press mortar tightly into the joints.*

▼ *Smokepipe from furnace fits into round chimney opening, then joint is sealed with asbestos cement, mixed to paste and applied with hand pressure around the pipe.*



Break-front China Cabinet

Build this showpiece in a few evenings

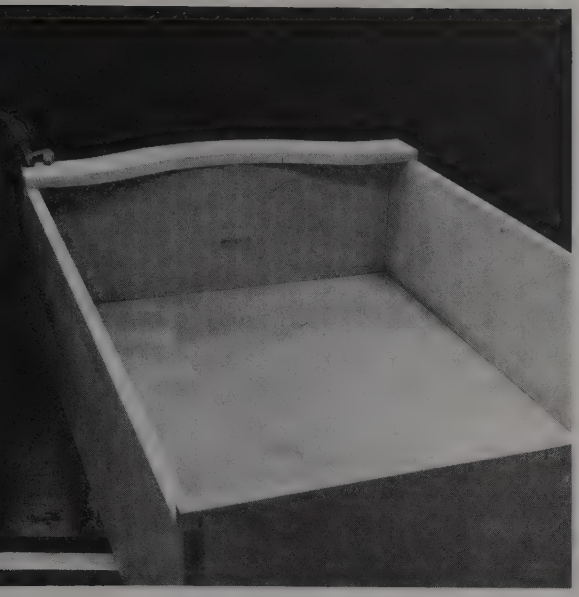
THIS ELEGANT piece of furniture, made of birch lumber core, has an expensive appearance but can be built for relatively little cost. Featured are a curved molded pediment, raised panels, glass shelves, and ample storage space in the base. The glass shelves are easily removed for washing and they allow light to penetrate and thus brighten up the chinaware.

The cabinet is made in two separate sections thus making it easier to build. The lower part is made first. Cut the sections to size, then rabbet the rear edges to accommodate the back panel and assemble using glue and finishing nails. Nails are used only where they will be hidden by moldings; otherwise dowels are used as in the doors. The one exception is the use of brads to attach the moldings.

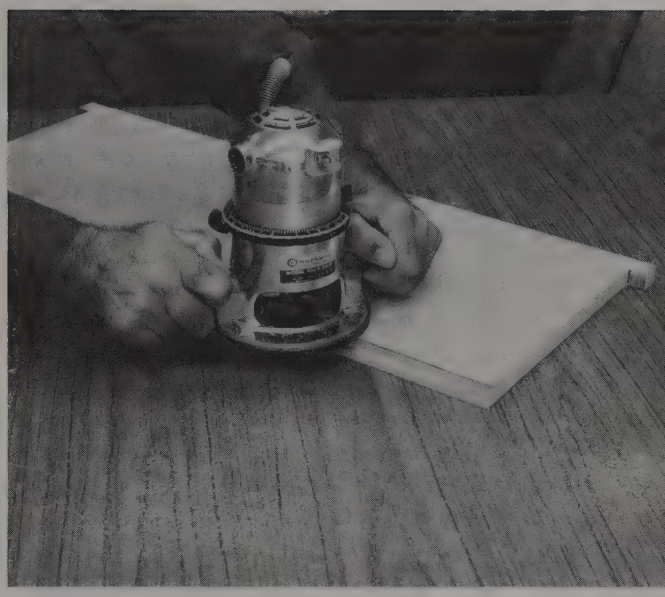
The rabbeting can be done by one of several methods. The shaper, jointer or router are fine. Another tool often used for rabbeting is the table saw. If the saw is used, make the vertical cut first. Since lumber core birch is used, it is not necessary to hide the edges. Simply sand them smooth.

Add the base pieces next. These are cut so the front piece overlaps the sides. Use dowels to join the pieces. You'll need clamps for this operation. Dowels should be the grooved type. If you use plain

chip carving: see carving



▲ *Curved pediment adds to the appearance of cabinet. Sand edges before assembly.*

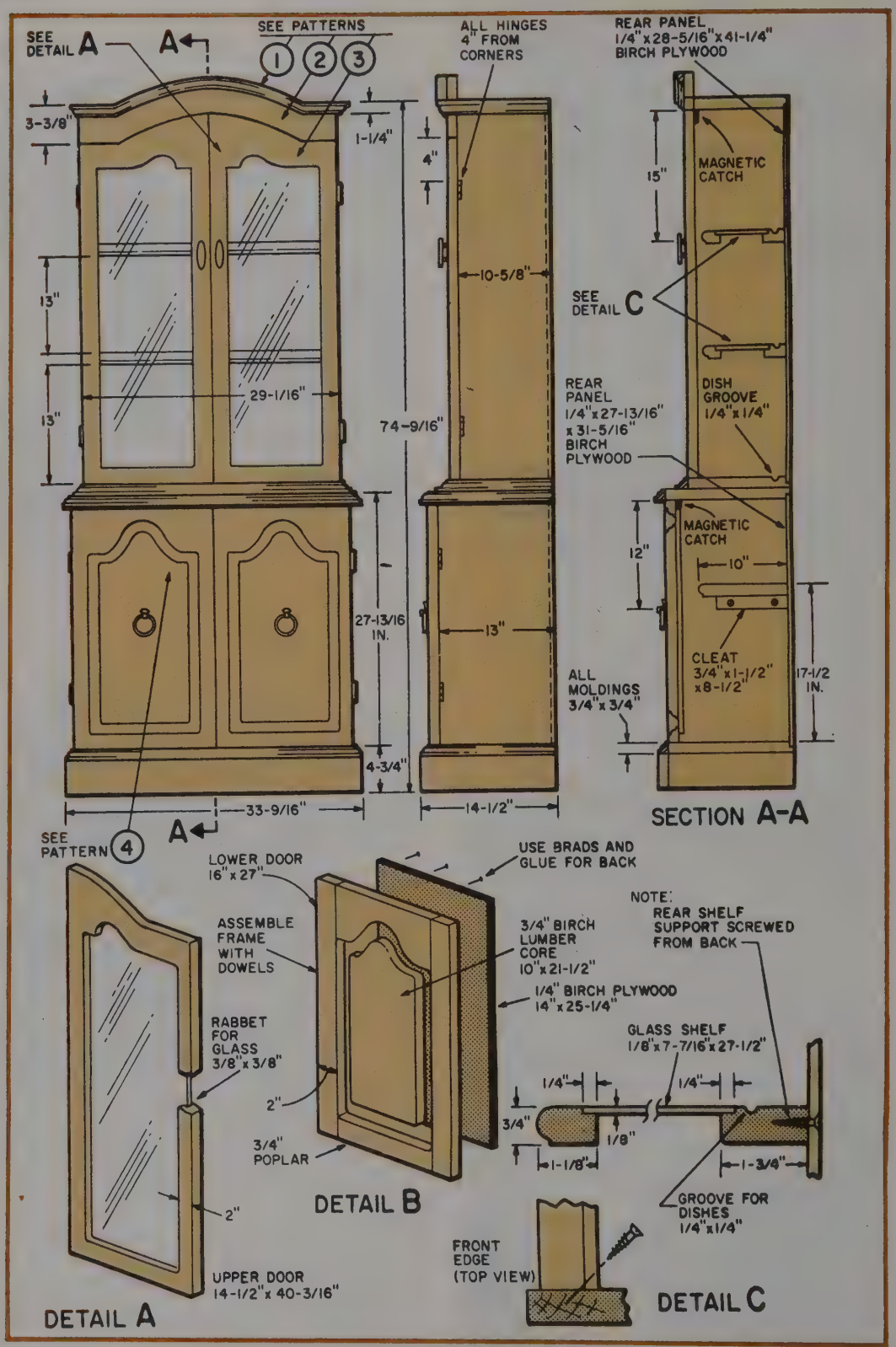


▲ *The router is used to cut rabbets to accept the back panels. Use square bit.*

▲ *With suitable cutter, cut molded edge on the shaper. Cut top curve after shaping.*

◀ *Notches for bottoms are made on the table saw. Stop cut as shown.*

CHINA CABINET

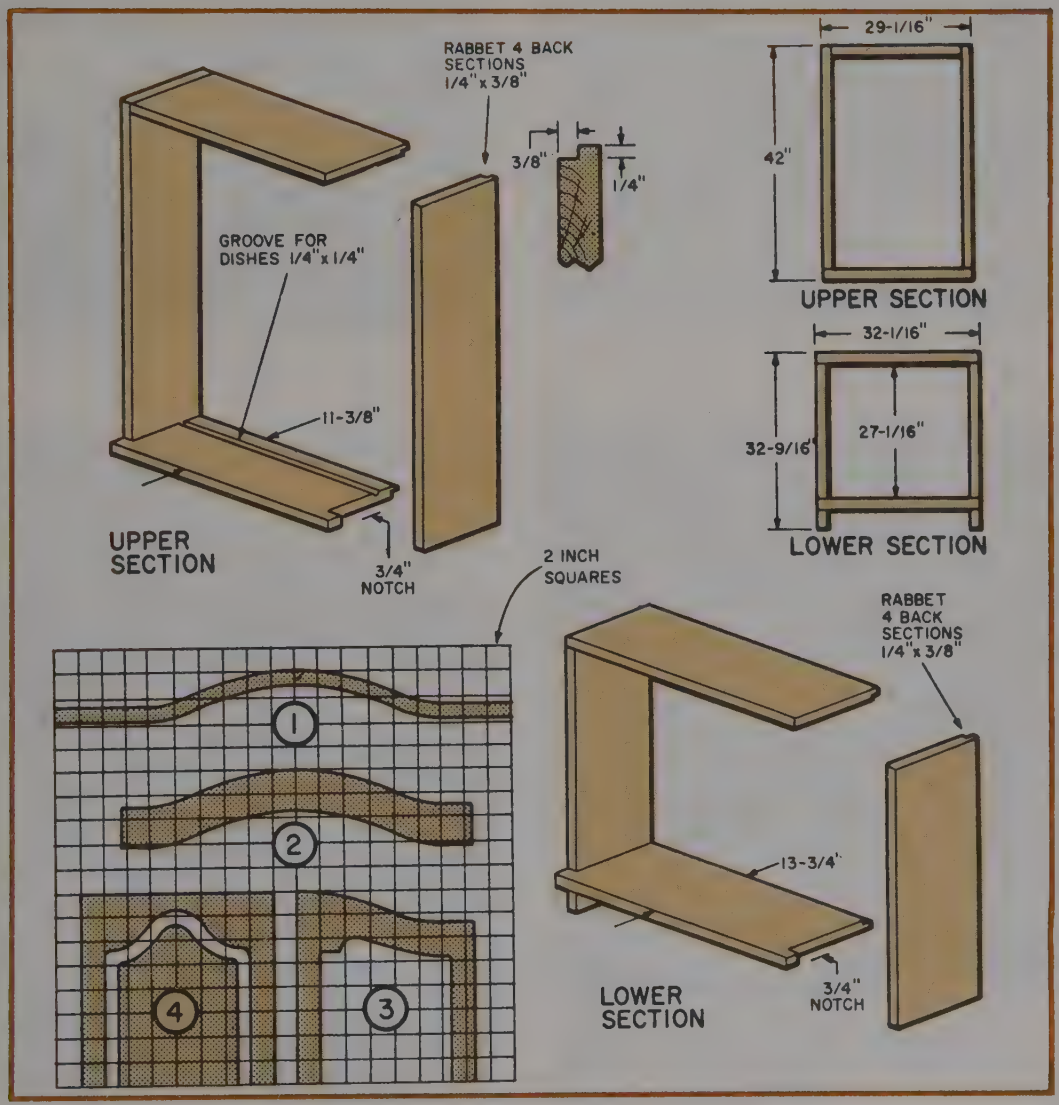


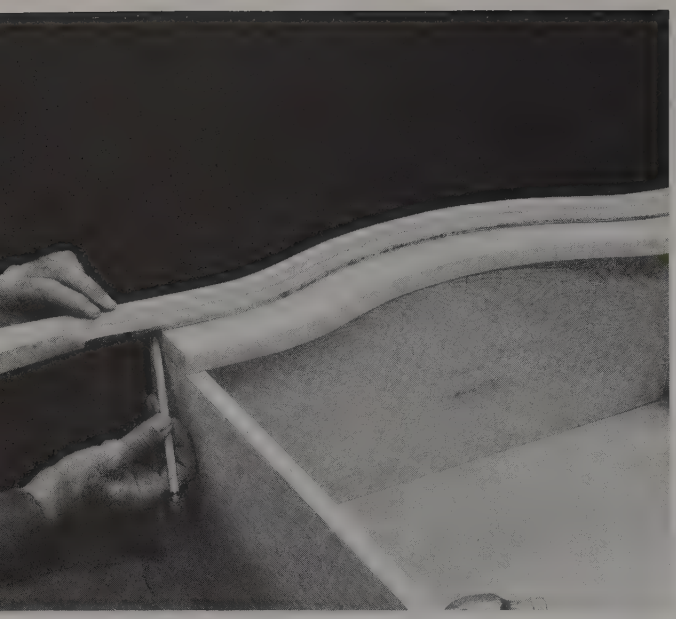
dowels, crimp the edges with a pair of pliers to form grooves. This will make for a tighter joint.

The upper section of the china cabinet differs from the lower in at least two respects. The top features a graceful curved pediment, and the base piece (of the top) is notched at the sides. Cut the sections to size, and then cut the curved pediment. While we used a band saw, it can be done with a saber saw. Use poplar or other hardwood for this piece. The bottom piece is best notched on the table saw using the miter gauge to support the work.

Before assembling, sand the pediment to remove all saw marks then join the sections. A nail can be placed at the upper part of the pediment as the molding will conceal it. There is nothing wrong in using nails even where the heads will show, but it makes for a finer, better finished piece of furniture if they are hidden. Use clamps to hold the pieces while the glue sets.

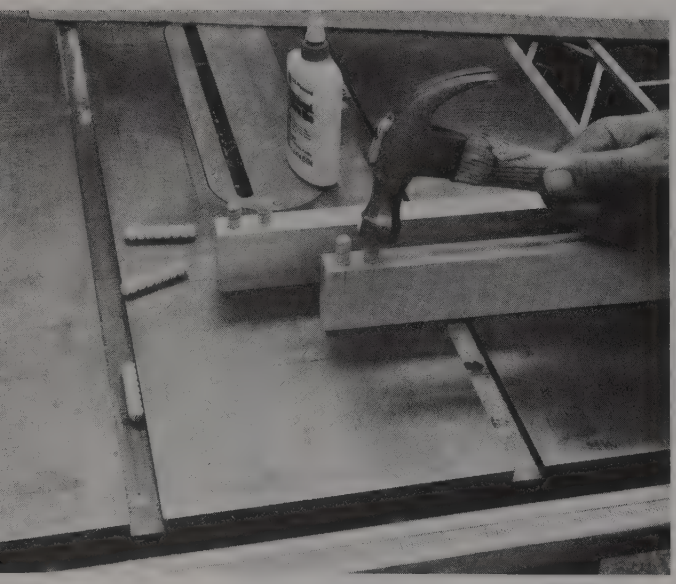
The curved pediment molding looks



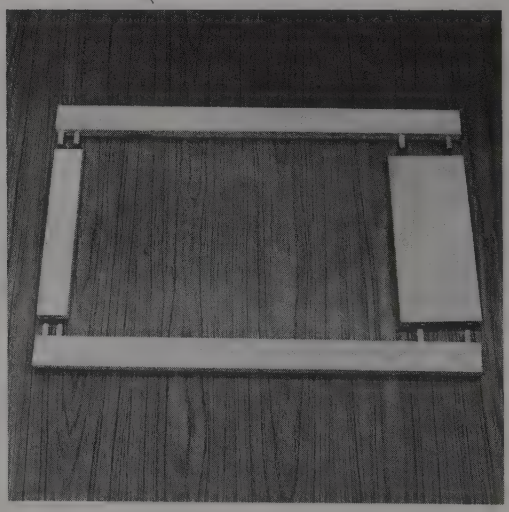


Before cutting miter, measure shaped piece carefully as shown. See text for details on shaping the piece.

Dowel jig simplifies drilling holes in door members. Tape on drill shows depth.



Door frame before assembly. Test the parts for accurate fit before you glue them.

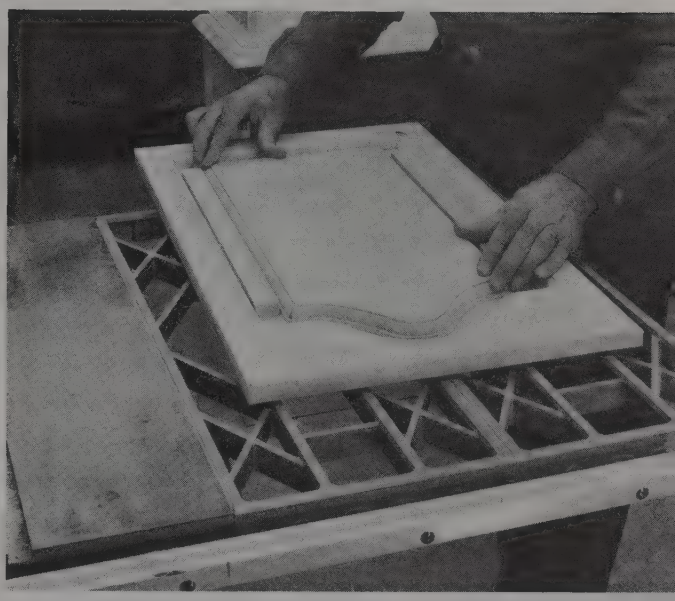


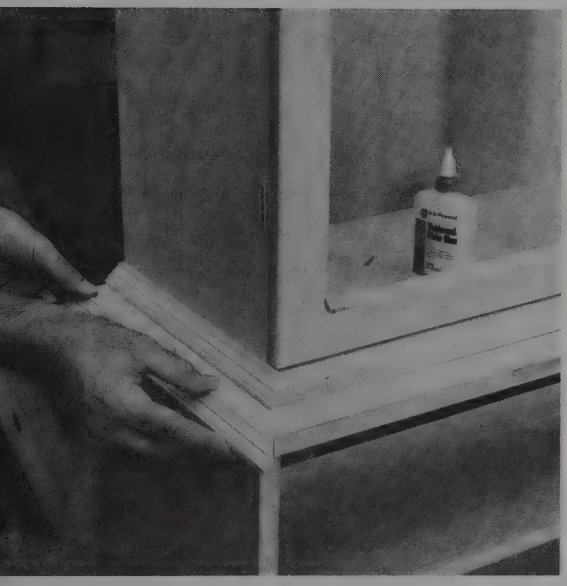
Spiral-grooved dowels are recommended as they hold better. Grooved dowels can be purchased at lumber suppliers.

Break-front China Cabinet

▲ *Raised panels for the front of the doors are made by shaping the outline with a router. Lumber core birch cuts easily.*

▼ *Use one inch wide strips of scrap wood to center the raised panel in the door.*





▲ *Shaped molding is mitered and attached to edges as shown. You can make the molding yourself or use ready-made stock.*

▲ *Shelf supports for glass are rabbeted to accept glass. Make rabbet $^{1}/_{8}$-in. so glass fits flush with top of shelf supports.*

tricky but it is quite easy to make. Draw the outline of the molding onto a piece of poplar about four inches wide (see the accompanying drawing). Then, using router or shaper, cut the desired profile. The advantage of using the shaper is that a larger profile is possible than with the router. If the shaper is used, insert the starting pin to prevent kickback.

After the piece is shaped, cut the top line on the band saw, miter the corners, and mount it as shown in the photograph. Using the same profile cutter, make the rest of the molding for the base and midsection.

The lower doors are made from poplar and consist of three sections: frame, raised panel, and backpiece. Cut the framing to size and assemble it with dowels. (A dowel drilling jig is handy as it assures alignment of the pieces.) The curved part of the upper rail is not cut until after the frame is glued. Should it be cut before gluing, clamping pressure may split the narrow part. When the glue has set, cut the curve and then rout the edges to suit using a beading or ogee bit.

After routing the inside edge, cut the rear panel to size and mount it with glue and brads. Next, cut the panel inserts to size and use the router (with the same bit) to shape the edges. Center the panel in the door frame and again assemble with brads and glue. As an aid to centering the panel, cut three scraps of wood, one inch wide, and use them as temporary spacers at the sides and bottom. This will automatically center the panel.

The upper doors are made in a similar manner, but they are left open to accept the glass. After cutting the decorative bead on the inner edge, cut the rabbet on the underside for the glass. If desired, a brass grille may also be used with the glass. The depth of the rabbet will be determined by the thickness of the glass and grille.

The lower shelf is supported by means of the two cleats. The wood strips to support the glass shelves are held with screws. The

▲ *Hinges are fully mortised in the sides of the cabinet. Brass butts work well.*

➤ *Corner detail shows construction of the door and top. Glass is held in place with plastic bead available at glazier shop.*

Break-front China Cabinet 557

MATERIALS LIST—Lower Section

Quantity	Size and Description	Purpose
2	3/4" 13 3/4"x32-1/16" birch	top and base
2	3/4" 13 1/8"x31 7/8" birch	sides
1	1/4" 27-13/16"x31-5/16" birch plywood	rear
2	3/4" 1 1/2"x8 1/2" poplar	shelf cleats
1	3/4" 10 1/4"x30-9/16" birch	shelf
2	3/4" 4"x13 3/4" poplar	base sides
1	3/4" 4"x33-9/16" poplar	base front
4	3/4" 2"x27" poplar	door sides
4	3/4" 2"x12" poplar	door top and bottom
2	3/4" 10"x21 1/2" birch	raised panel
2	1/4" 14"x25 1/4" birch plywood	door back

NOTE: Also need, screws, glue, hinges, pulls, nails, brads, dowels, etc.

MATERIALS LIST—Upper Section

Quantity	Size and Description	Purpose
1	3/4" 10-11/16"x27-9/16" birch	top
1	3/4" 11 3/8"x29-1/16" birch	base
2	3/4" 10 5/8"x42" birch	sides
1	1/4" 28-5/16"x41 1/4" birch plywood	rear
2	3/4" 1 3/4"x27-9/16" poplar	rear shelf supports
2	3/4" 1 1/8"x27-9/16" poplar	front shelf supports
1	3/4" 6"x29-1/16" poplar	pediment
1	3/4" 1 1/4"x25" poplar	top molding
1	3/4" 3 3/4"x31" poplar	curved molding
2	3/4" 2"x37 3/4" poplar	outer door sides
2	3/4" 2"x40-3/16" poplar	inner door sides
2	3/4" 4 3/4"x10 1/2" poplar	door top
2	3/4" 2"x10 1/2" poplar	door bottom
	3/4"x182" poplar	molding for entire unit

NOTE: Also need, screws, glue, hinges, pulls, nails, brads, glass, dowels, etc.

glass shelves should be of double strength glass. This is a little thicker than window glass and is available at glazier shops. The door glass can be single strength. Brass butt hinges are used for the doors. Cut full mortises in the side panels and mount the hinges carefully.

Sand the entire cabinet, then stain the desired shade. To complete the job, apply a suitable finish. J.C.

How to Use Chisels

Every workshop needs a selection of these tools that chip, carve, shear, pare and gouge. Here's how to pick them out and how to put them to work

Tang, or paring, chisel has tang embedded in plastic or wooden handle. Use it for handwork. Remember: It's not built to take hard mallet blows.

Socket chisel takes mallet blows better than a tang chisel. The socket distributes shock through the larger portion of the handle. Beveled sides permit work in close quarters.

NO MATTER how many power tools you own, your shop is not complete unless you have an effective selection of chisels. There are many woodworking operations that still can be done only with hand chisels, or done better and faster than with a power tool. You can use chisels and gouges for paring, trimming, mortising, chipping, carving and metal work. And, there are times when you would be justified in spending a few extra dollars on special chisels that are used by various craftsmen such as plumbers and electricians.

There are two basic categories of wood chisel. A *tang* chisel has a tapered extension (the tang) at the rear of the blade that fits into a hole in a wood handle, or which is embedded in a plastic handle. If the handle is of wood, there's usually a metal ferrule at the lower end to minimize chances of splitting the wood, and a shoulder on the tang to keep it from working too deeply into the handle. A *socket* chisel has a conical extension (the socket) behind the blade that accepts the tapered end of the handle.

Tang chisels, also called paring chisels, are used for light work. They should not be used for work requiring the use of a mallet. Since the tang is relatively light, most of the chisel weight is concentrated at the blade end; this makes for much easier handling when making delicate cuts. Many tang chisels having wood handles have leather caps at the butt ends of the handles so that the handles can take moderate tapping with a mallet.

A socket chisel can take much harder pounding since the handle, locked inside the socket, is not as easily split. The handle

chisels, carving: see carving
chisels, round nose: see lathe
chisels, skew: see lathe

➤ *Broad glazing chisel is designed for glass-setting jobs that include removing old putty, setting glazing points and re-puttying.*

➤ *Electricians chisel is made entirely of alloy steel. It cuts through lath, siding, plaster and dry wall materials.*

➤ *Made entirely of drop-forged alloy steel, this wood chisel can be used for work that requires extra hard hammer blows — tearing up floors for example.*

➤ *This tang chisel can take hard blows. The tang runs through the handle and is part of the steel cap.*

butt of a socket chisel is also usually protected by a leather cap.

The basic difference in these two categories of chisels is the manner in which the blade is attached to the handle. The blades themselves may be very much alike when the tools are intended to be used for similar purposes. For example, most chisel blades have bevels on the two long edges so that the blades can more easily be moved about in tight places. However, there are chisels having square-cut edges for use under conditions that might put uncommon strain on the blades.

One relatively new variety of tang chisel has a tang that goes all the way through the handle to join the metal butt cap. Obviously, this type can be pounded with a mallet without fear of damaging the handle. It can also be used for hand paring, hence it is favored by many as an all-around chisel. Another version of this type of tang chisel eliminates the wood or plastic handle entirely. It's a rugged workhorse, but you may not like the feel of the metal shaft in your hand as much as a wood or plastic handle. Such chisels are especially good if you work in places where wood or plastic handles might be damaged—by fire or hot objects, for example.

Many variations. Although there are two basic categories of chisels, these groups

break down into many other sub-classifications according to how they are to be used.

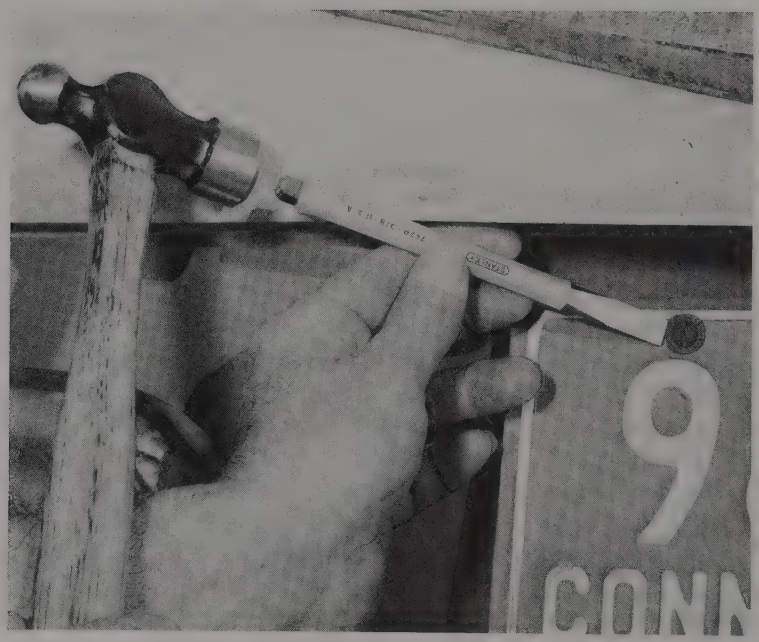
As in all trade nomenclature, you will find some ambiguities. A tang chisel is also commonly referred to as a *paring* chisel because it is generally used to make fine cuts (paring) or to trim to a line. However, even a socket chisel can be considered a paring chisel if it has a thin, beveled blade that is suitable for fine work.

In contrast, a *firmer* chisel is better for more all-around work because of its greater strength (the long edges of the blade are square rather than beveled). A *framing* chisel, which *does* have beveled edges, is recognized by its heavy-duty blade and a rugged ferrule at the handle butt to resist heavy mallet blows. This type of chisel is used mainly in building house frames, and in such other applications as shipbuilding.

Chisels made specially for cutting *mortises* have relatively thick blades that can be used in prying, lever fashion, when making deep mortises. Need a chisel you can handle in cramped quarters or in awkward positions? Then try a *butt* chisel which has a relatively short blade that contributes to better hand control of the tool.

Of course, all chisels are available in many widths. Generally, blades from ⅛- to 1-inch width are available in $\frac{1}{16}$-inch increments, and chisels ranging from 1 to 2 inches come in ¼-inch increments. You need not have every conceivable width as well as variety of chisel, but you should have a variety that will enable you to use a broad chisel for long cuts and narrow chisels for narrow cuts.

Probably, a few carefully selected flat chisels of the kinds so far discussed will handle ninety percent or more of your chiseling jobs. But your craft work may also call for more specialized chisels. *Gouges,* for instance, are chisels with curved rather than flat blades. There are two basic types of gouges: An *inside bevel gouge* having the cutting edge bevel ground onto the concave side of the blade; and an *outside bevel gouge* having the bevel ground on the convex side of the blade. The former is handy when you want to round off the edge of a table, for example,



Cold chisel is used for cutting through rusted bolts and other metal objects. When looking for chisel of this type make sure it has chamfered butt ends that can receive hard blows without chipping.

while the latter is mainly used for making grooves and fluting. Most gouges have the handle set in direct line with the blade, as with flat chisels. But you can also buy gouges having offset handle which are desirable when your hand must be close to the work being chiseled.

If you do much fine work, perhaps model building, you can hardly get along without a complete set of very small chisels and gouges—so-called carving tools.

There are times when buying a special type of chisel is worth the cost. For example, if your windows are all in pretty bad shape, and you plan to do a complete refurbishing job including reputtying, you should acquire a broad-bladed glazing chisel with which to remove old putty, set glazing points, and even apply new putty. Also, if you are doing inside remodelling that requires chiseling openings into lath, siding, plaster or dry wall materials, you can save time and effort using an electrician's chisel.

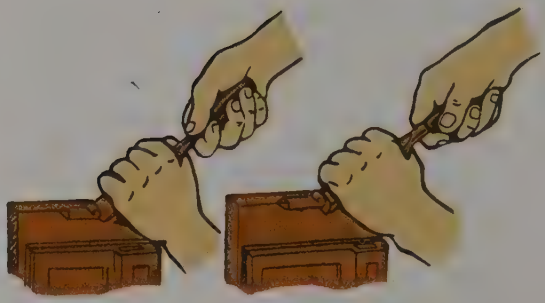
One chisel that is a virtual must in any home shop: a *cold* chisel made of especially hard and well-tempered steel alloy that can be used to cut through metal. You will appreciate a cold chisel the very next time you must remove a rusty bolt that just can't be separated from its nut by gentler means.

How to be a chiseler. The first thing to learn about chiseling techniques is proper care of your tools. If these tools are abused, they not only will do poor work, but will be unsafe to handle. Wipe the metal parts of each chisel with light oil to prevent rust. Whet the blade on a fine oil stone *frequently* because it's far easier to keep a chisel in good shape by repeated, brief passes over a good stone than to bring it back to life after it has been nicked or otherwise made excessively dull. Grind the blade only if it is nicked, or if the bevel has been worn too short. Chisels are usually ground to a 25- or 30-degree angle. And do not throw your chisels helter-skelter into a drawer; provide a rack that will hold the tools apart, and keep the blades from contacting other hard objects.

▲ *Far enough. When you're two-thirds through a notch, complete the cut from the other side to avoid breaking off extra wood. Light mallet blows will take out most of the wood. Hand pare the cut to smooth out roughness.*

If you are right-handed, power is applied to the chisel with your right hand while the left presses the blade to the work and controls the blade action. If you are a south-

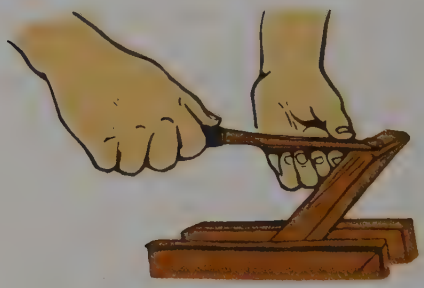
For a horizontal cut, hold chisel slightly to one side and push it through the work, always cutting with the grain. Hold it bevel down for roughing cuts, bevel up for paring cuts.



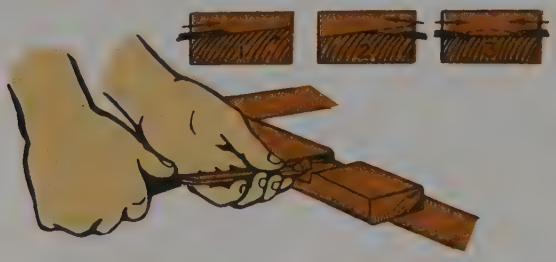
To chamfer, incline chisel parallel to the slope of the chamfer and cut as in chiseling horizontally with the grain.

Hold chisel so that it makes a sliding horizontal cut when chamfering on end grain. The chisel is moved sideways across the corner of the work.

Cut a slanting corner by holding work in vise with guide line horizontal. Cut with the grain.

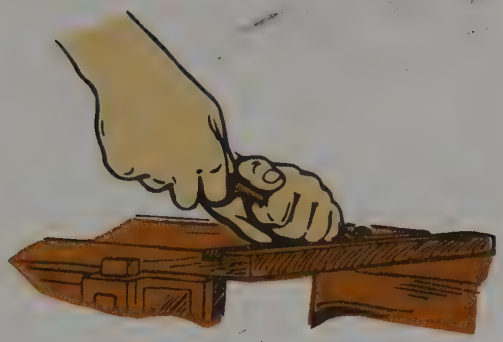


When cutting horizontally across the grain, use a vise to hold the work; hold the chisel with the forefinger and thumb pressed together to act as a brake. Cut half way from each edge toward the center to avoid splintering the corners. Remove center stock last.



The work is held against a bench hook while you cut across the grain; steady the work with the heel of your left hand. Use the fingers to press the chisel firmly against the wood.

paw, reverse the roles of the two hands. Hold the chisel slightly turned so that the edge *slices* across the work at an angle instead of butting into it head on. You do the same thing with a knife when you cut a loaf of bread; you would end up with a pretty sad looking slice of bread if you just pressed the knife blade directly downward through the loaf. It's pretty much the same with a chisel. A slight turn of the blade not only produces a smoother cut, but does so with far less physical effort on your part.

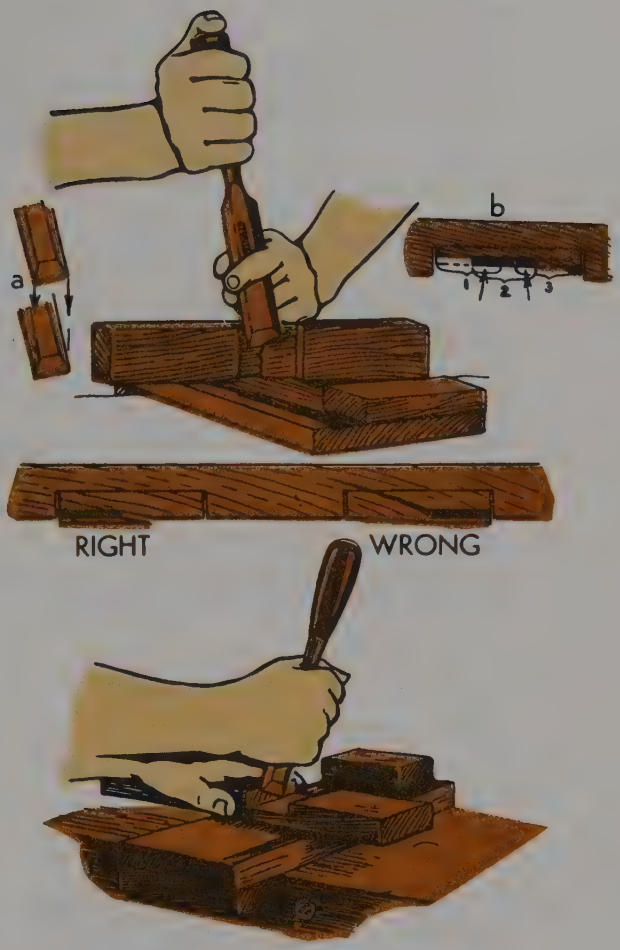


If the work is wide, hold the chisel bevel down. Then, the handle will clear the work and the blade will not dig in too deep as it moves forward.

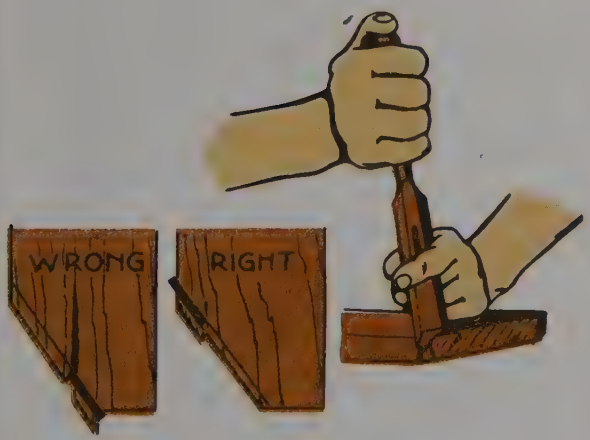
Keep both hands behind the blade so that should the tool slip there would be no chance of cutting yourself. This is a fundamental rule when using any tool, but doubly important when using sharp chisels.

Horizontal chiseling. To make the simplest type of horizontal cut, hold the chisel with the edge slightly turned to one side and push the tool away from you. For rough, fast cutting, hold the bevel side down; for fine paring cuts, keep the bevel side up.

Chamfering is much like straight horizontal chiseling except that the tool is inclined to one side, parallel with the slope of the chamfer. Incidentally, always make horizontal cuts with the grain to eliminate

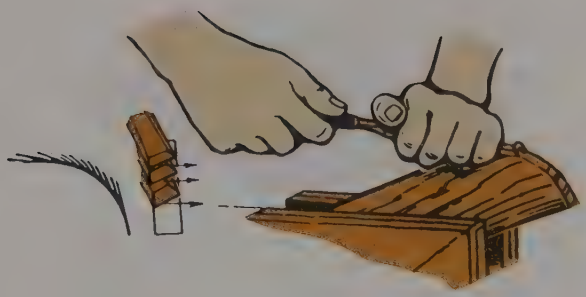


Tilt the chisel slightly to one side when cutting vertically across the grain to give the cutting edge a sliding action, or hold the chisel straight and move it from side to side during cutting. When making a series of side-by-side cuts, overlap them slightly so the surface of one cut guides the chisel through the next cut. Make a series of cuts with the grain, so if a split develops it will travel into the waste rather than into the work. Use a chisel like a knife to clean the corners of a tenon, notch, dado or rabbet. To do this, grasp the tool near the cutting edge, raise one corner and draw it toward you.



To cut a slanting corner vertically, use the chisel in the same manner as in vertical cutting across the grain. Always cut from the edge toward the end so the wood will split away from the line.

When the cutting edge of a chisel is across the grain the mallet can be used safely. Use of a mallet when the edge is with the grain is likely to split the work. The mallet may be used when excavating a mortise.



To cut a round corner, move the chisel sideways across the work, making a series of close cuts. Each cut should be tangent to the curve.

chances of splitting the wood or of cutting too deep accidentally.

To cut diagonally across the wood grain, use the same horizontal cutting technique. The work must be held fairly securely in the vise since there will be somewhat more resistance to the cutting action than when you are chiseling completely with the grain.

A chamfer on end grain is made by moving the chisel sideways across the corner of the work. The chisel should make a sliding horizontal cut.

A series of short, tangential cuts are used to make a rounded corner. Once again, move the chisel sideways across the work as indicated in the detail sketch.

Cutting horizontally across the grain

To cut a concave corner, hold the bevel side of the chisel against the work and push the blade down; draw the handle away simultaneously to give a sweeping curve to the work. Always cut with the grain toward the end of the work.

calls for a somewhat different technique. The left forefinger and thumb grasp the chisel blade and the forefinger presses against the work to act as a brake; in effect, the power push provided by the right hand is just enough to overcome the braking action of the left hand. This technique provides the control needed to make good across-the-grain cuts. To avoid splintering, cut halfway from each edge to the center of the stock, at a slight upward angle; then level off the middle section with a controlled paring action.

Another way to cut across the grain is to hold the work against a bench hook. The heel of the left hand steadies the work while the fingers press the chisel firmly against the wood.

If the work is wide, hold the chisel with the bevel down so that the handle will clear the work and so that the blade will not dig in too deeply during each pass.

Vertical chiseling. You can make the same type of cut across the work by means of this vertical technique or by the horizontal method. The chisel should be tilted slightly to one side to provide the desired slicing action. You may find it easier to hold the cutting edge straight and move it to one side. If the chisel is narrower than the surface being worked, part of the chisel blade is pressed against the wood already cut to help keep the cutting portion of the blade in line.

The chisel is used the same way as in vertical cutting across the grain when a slanting corner is to be made. Always work from the edge toward the end so that wood will split away from the line. If you work from the end toward the edge, the wood is almost sure to split because you would then be cutting against the grain.

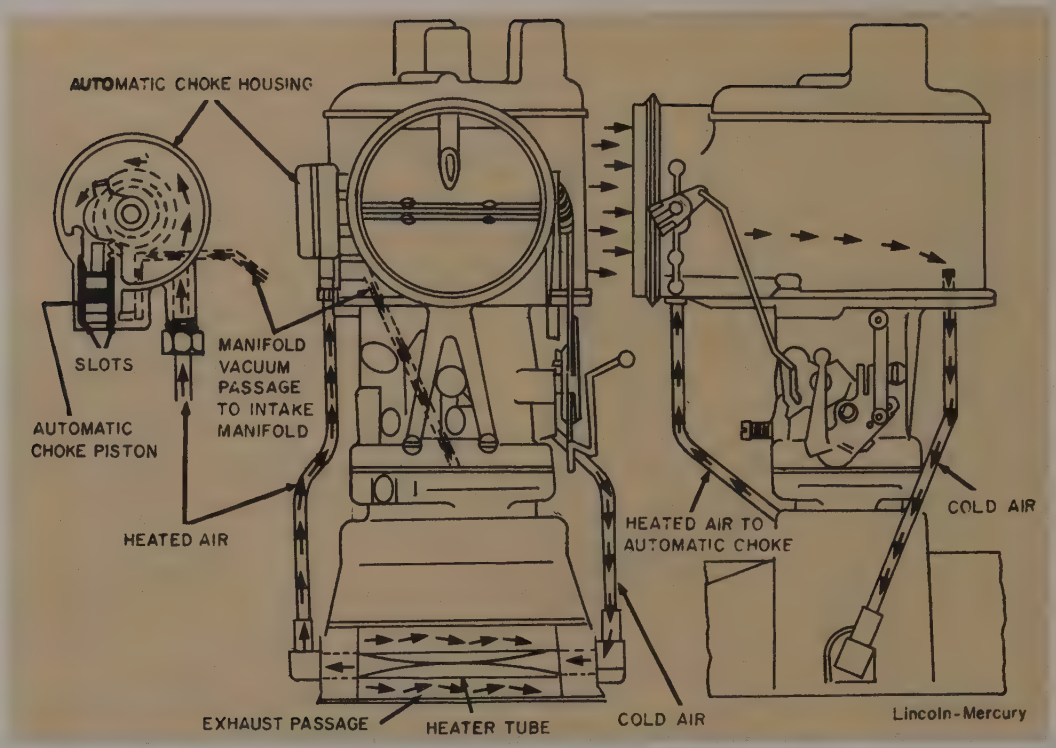
Use a chisel to clean the corners of a tenon, notch, dado or rabbet. Grasp the chisel by the *blade,* near the cutting edge. Raise one corner of the cutting edge by tilting the chisel away from you, then draw the chisel through the work, toward yourself. Hold the work with the left hand (keep thumb off to one side of the cut). Note that in this case the chisel is used more like a knife than a chisel per se.

To cut a concave curved corner, hold the bevel side of the chisel against the work with the left hand while the right hand presses down and draws back on the handle at the same time. This technique gives a sweeping curved direction to the cut. Always work with the grain, from the edge toward the end.

Note that all of these basic cuts have been made wholly by hand action, without pounding with a mallet. However, there are times when mallet-power is required to do the job more efficiently and quickly. In general, it is very risky to use a mallet when the cutting edge of the chisel runs parallel with the wood grain because of the danger of splitting the work. It's much safer to use a mallet when the chisel edge is oriented across the grain. In fact, it's the added resistance to cutting that cross-grain causes that calls for the use of a mallet. The mallet may be used on the chisel to beat out a mortise, to cut the ends of a mortise after the bulk of the material has been bored out, when the wood is unusually hard so that hand chiseling is too difficult, and when a large amount of wood must be removed during roughing operations.

The use of *gouges* is much the same as the use of flat chisels. Just bear in mind that while you could make a broad groove with a relatively narrow flat chisel (although a wide chisel would do the work better and more easily), you must have a gouge with the right width and curvature to create a round-bottomed groove of a particular size. As with flat chiseling, you can use a mallet on a gouge when making heavy cuts during roughing out steps; but you should use very light hand cuts when doing the finishing work. J.H.

See also: HAND TOOLS.



Drawing shows how the typical in-carburetor piston choke works.

How to Service Your Automatic Choke

Keeping your choke in shape can avert starting difficulties and prevent gasoline from harmfully diluting your engine's oil

WHEN THE ENGINE in your car is running at normal temperature, each part of gasoline has to be mixed with about 14 parts air in order to burn in the cylinder combustion chambers. But, when the engine is cold, it needs a richer mixture—more fuel and less air. The choke helps control this mixture.

It is likely, when starting a cold engine, that much of the fuel entering into the carburetor throat is in the form of small drops, and only a small portion of these will be properly vaporized by the time the mixture reaches the cylinder. By enriching the mixture and increasing the proportion of fuel to the proportion of air, sufficient vaporized gasoline can be delivered to the combustion chamber to start your engine and keep it running until the engine warms up enough to work on a normal fuel-air mixture.

Temporary changes in the fuel-air mixture are regulated by the choke plate in the carburetor throat. As the choke plate is closed, more fuel and less air is allowed down the throat.

The manual choke. On most older cars and even many late-model economy and sports cars and trucks, choke adjustments are accomplished manually by a pull knob on the dash. Pulling the knob out closes the choke, pushing it in opens the choke.

But manual choking has always been a

choke, shotgun: see shotgun
choose fire wood: see campfires
choose heating systems: see fuels

problem. It is simply too easy to overchoke the carburetor. The chance of overchoking has been removed by the automatic choke, a device which has been put on most cars since the late '40s and early '50s.

The automatic choke is a unit which reacts to the engine temperature. A temperature-sensitive metal coil opens and closes the choke plate in response to the action of the metal.

Automatic chokes today use some variation of the temperature-sensitive metal coil, and couple a vacuum-controlled piston or vacuum-controlled diaphragm to the choke plate linkage. Until the thermostatic coil becomes warm, its tension is relatively high so that neither the suction effect in the carburetor nor intake manifold is sufficient to overcome the tension, or the tension is high enough to overcome the downward pull of the piston. As the thermostatic metal warms, its tension decreases.

The vacuum-controlled piston or vacuum-controlled diaphragm or piston is connected to the choke linkage in such a way as to oppose the thermostatic coil. The coil tries to keep the choke plate closed; the diaphragm or piston, which is being drawn by engine vacuum, tries to pull it open.

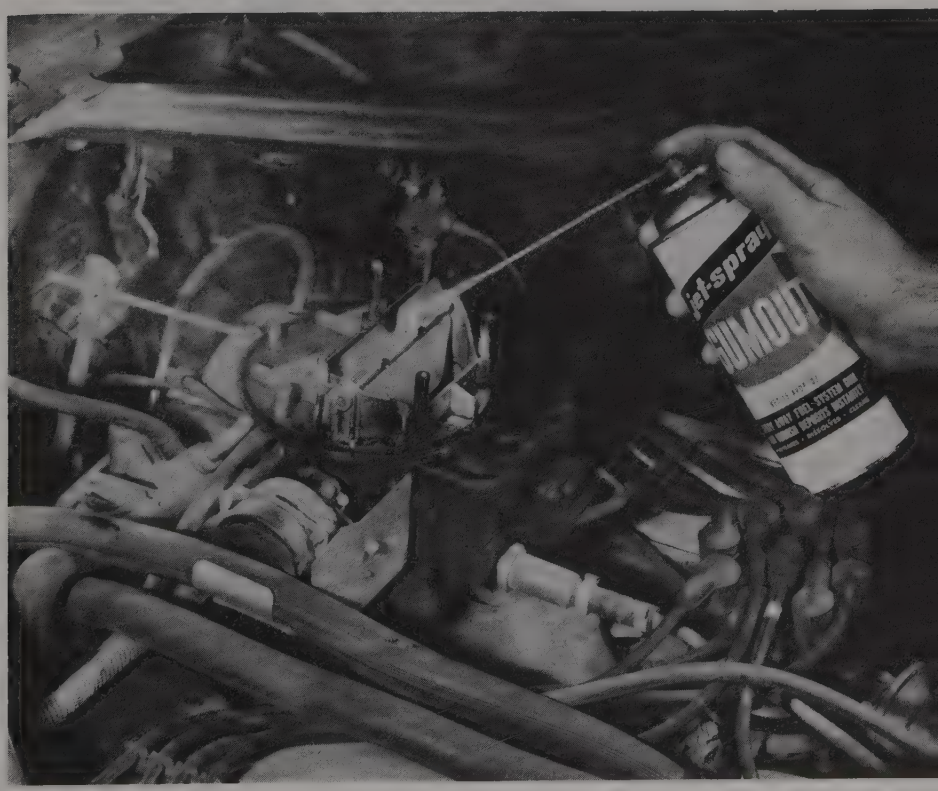
As the thermostatic coil tension decreases, the diaphragm or piston pulls on the choke linkage, gradually opening the choke.

The thermostatic coil can be located in either of two places: a cast well in the intake manifold, or in the carburetor itself.

If the coil is in the intake manifold well, there is a rod from the coil up to the choke linkage on the carburetor.

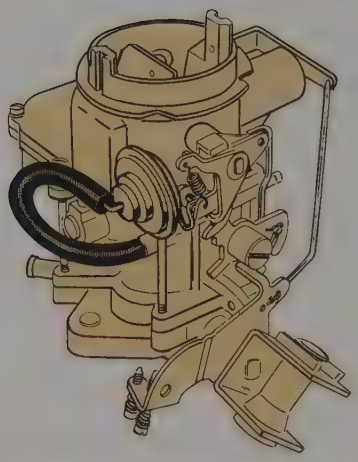
Current design practice is to use a vacuum diaphragm with the well choke and a piston with the in-carb unit.

The vacuum diaphragm is mounted on the outside of the carburetor, where it can

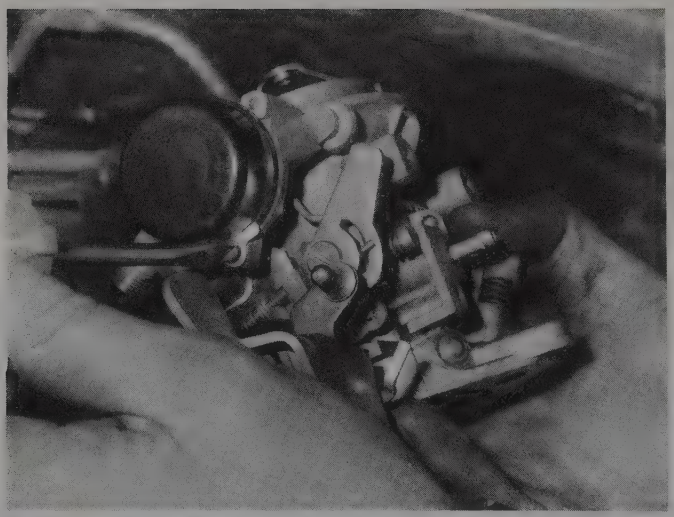


➤ *Keeping automatic choke's external linkage and choke plate clean is a preventive maintenance job that takes just seconds when using an aerosol solvent.*

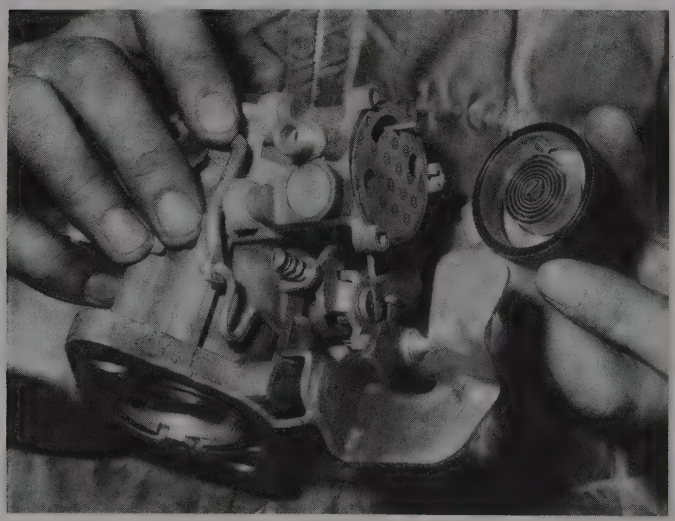
How to Service Your Automatic Choke



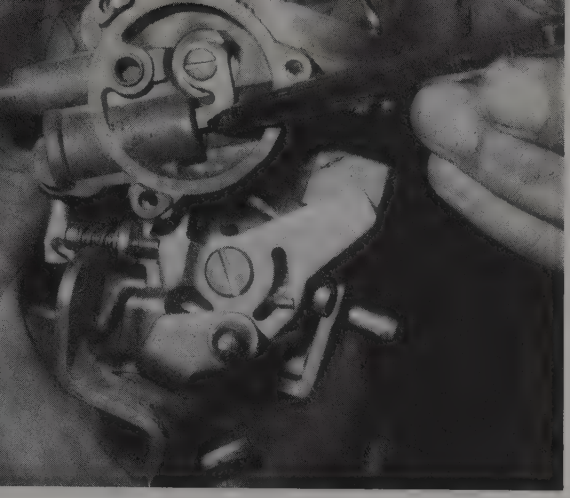
This is carburetor with vacuum diaphragm to pull open the automatic choke, instead of the in-carb piston.



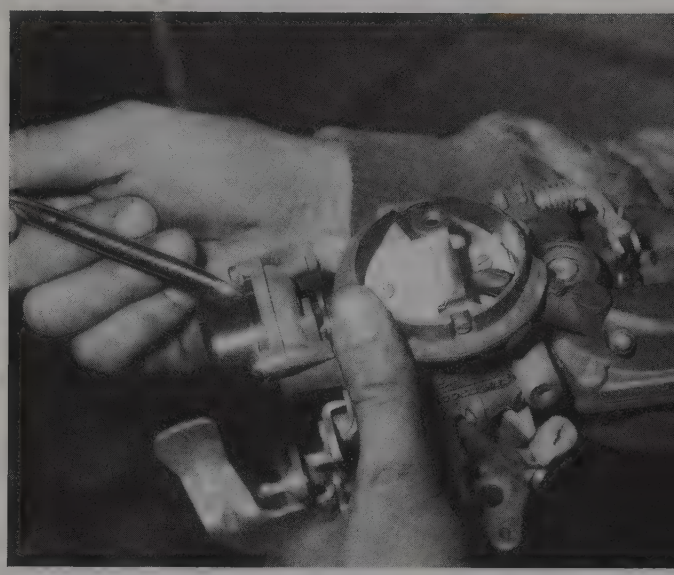
In-carb piston is accessible through plastic cover, which is held on by screws. Before disturbing, note alignment mark on top of cover and what it matches up with on carb body.



Cover off (note thermostatic coil in cover). Now remove gasket. Rod projecting from gasket is linked to vacuum piston. When cover is on, rod engages thermostatic coil.



Pen points to vacuum piston bore. Below: When putting choke together, be sure cover mark is aligned with marks on carb body.



easily be checked and replaced. It is connected to the carburetor base or intake manifold (the source of vacuum) by a short hose.

The piston is inside the choke assembly, just back of the thermostatic coil. A passage in the carburetor runs from the back of the piston to the intake manifold, the source of vacuum.

The hose or tube you see on the outside of the housing for the in-carburetor coil choke is a heat tube. It runs to the intake manifold, and is the source of heat for the thermostatic coil.

Problems with an automatic choke. An automatic choke is anything but a foolproof item. Among the things that can go wrong are:

1. Sticking linkage.
2. Improper adjustment.
3. Weak thermostatic coil.
4. Seized thermostatic coil.
5. Stuck vacuum piston or defective vacuum diaphragm.
6. Clogged heat tube (in-carburetor coil chokes only).

If the choke fails to close, or opens too soon, the car will be very difficult, if not impossible, to start. If the choke sticks closed, the engine will stall and when it does run, the mixture will be overly rich—overchoked.

Overchoking is a very serious problem. Large quantities of raw gasoline enter the combustion chamber and the excess washes the oil from the cylinder walls, creating unnecessary cylinder wall wear. The extra fuel can flow past the rings and dilute the oil in the crankcase. Diluted crankcase oil may cause rapid wear of bearings and other fast-moving engine parts.

If you suspect trouble with the automatic choke, check its operation before you remove or replace it. Remove the air cleaner from the carburetor so you can see the choke plate in the carburetor throat.

When the engine is cold, the choke plate should be closed. Start the engine. The choke plate should open slightly and, as the engine warms, should open gradually. When the engine reaches the proper operating temperature, the choke plate should be fully open.

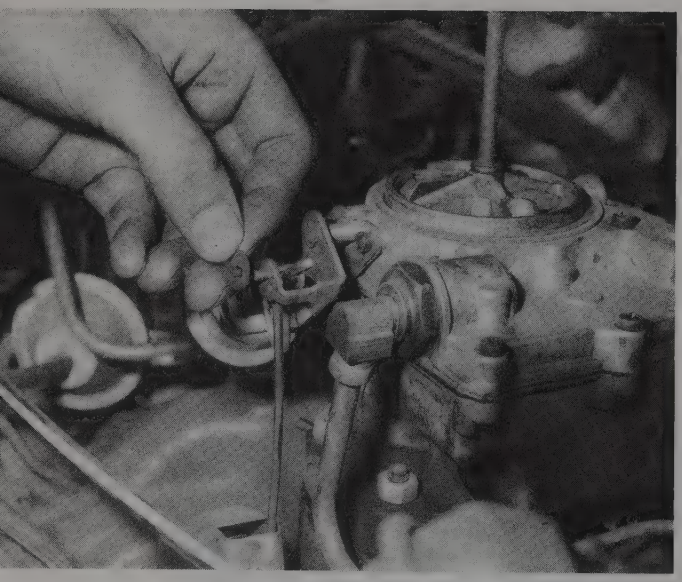
If the choke plate opens too soon or too slowly, you can compensate by adjusting the position of the thermostat spring cover. If the choke plate seems extremely slow opening, try this check before you remove the automatic choke. Accelerate the engine quickly, then release. The choke plate

should remain in full open position. Close the choke plate with your finger, then release it. It should open immediately. If it does not, the trouble may be caused by a bent or sticky choke plate shaft or a vacuum piston or diaphragm rather than the automatic choke.

Adjustment. If the automatic choke opens too soon or too late, you should be able to make an outside adjustment rather than complete repairs.

Most automatic chokes of the in-carburetor coil type are provided with a system of cover adjustments to control the thermostat spring reaction to engine temperature. By loosening three screws enough to move the choke cover, you can turn the cover left or right and change the spring reaction.

On most covers you will find an arrow marked "lean" pointing to the left. If you move the cover to the left, or to lean position, you will cause the choke to open at a lower engine temperature. If you turn the cover to the right, you will cause the choke to open at a higher engine position. The proper adjustment of the choke for your engine normally is at the mid position, or one line "rich." But if your car experiences any starting problems, check manufacturer's specifications. On some cars the specifications were as high as four lines rich for very cold weather.



To replace well choke, start by disconnecting link. This one is held by push-on clip.

The well choke normally requires no adjustment. If you experience hard starting and cold stalling that seems to be accompanied by an early-opening choke, there is an adjustment on some Chrysler Corp. cars.

Undo the screw or screws that hold the well cover, disconnect the rod from the coil to the choke plate and take out the thermostatic coil assembly.

There is a locknut that holds two coil tension indexing plates together. Like the other type of automatic choke, this one has markings. One plate has a notch, the other has calibration lines. If you loosen the locknut, you can realign the marks to increase spring tension, which will lengthen the time required for the choke to open fully.

The normal adjustment is to align the notch with the center calibration line or one line toward more tension (toward the "R"). If the choke fails to perform with this adjustment, the coil should be replaced.

Regardless of the type of choke, this cannot be overemphasized: a thermostatic coil adjustment is not a cure-all for a weak coil.

Note: On some Chevrolets, the rod from the well coil goes into an elongated hole on the choke linkage. With the choke closed, the top of the rod should be even with the top of the elongaged hole on six-cylinder engines. On virtually all V-8s with an elongated hole, the rod should be even with the bottom of the hole.

All moving parts of the automatic choke should be dry and free of dirt. Never oil linkages; oil collects dirt and causes the parts to stick and eventually bind.

The best "tool" for automatic choke service is an aerosol can of choke solvent. As part of every tune-up, spray the external

choke linkage clean. Remove the plastic cover on in-carburetor coil chokes and spray the solvent onto the piston and into its bore. Check the piston, which should move back and forth completely free.

With vacuum diaphragms, the only service is to check the operation of the unit. With the engine cold, start the engine and watch the diaphragm. If it is functioning, it will pull the link to which it is attached and crack open the choke. (The piston does the same thing.)

The cracking open of the choke by the diaphragm or piston gives an engine that has just been started enough air to run at fast idle.

If the vacuum diaphragm does not pull the link, pull off the hose and feel for vacuum. (Engine must be running.) If there is little or none, the hose is clogged or leaking, both very remote occurrences.

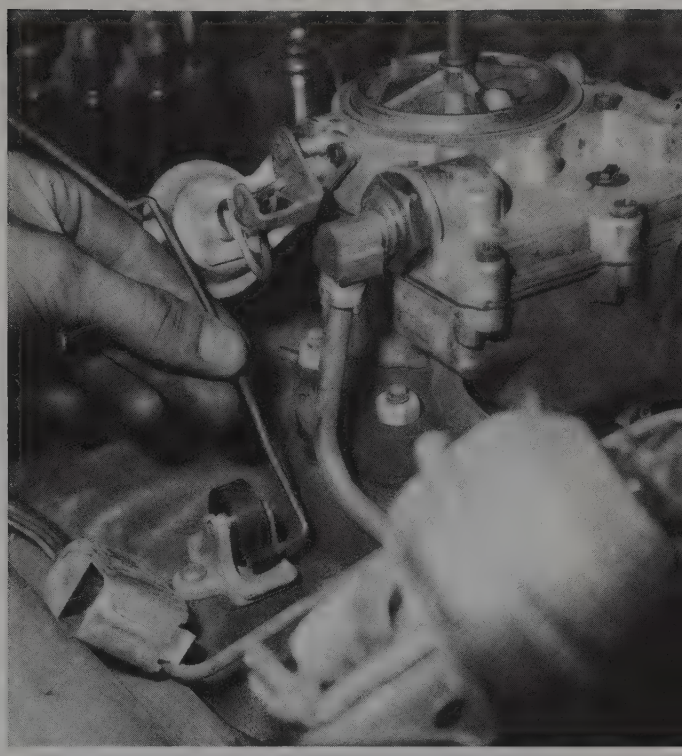
More likely, there is vacuum and the diaphragm has become porous, and the assembly must be replaced. This is a simple job since the assembly is held by screws.

The diaphragm or piston must crack the choke open only a specified amount. If the opening is too small, the engine will die for lack of air. If the opening is too great, the fuel mixture will be too lean and the engine will also stall out.

The initial opening of the choke is measured at its widest point, using a drill bit as a feeler guage (the drill should just fit in). The specification is referred to as the "choke vacuum kick" and varies according to carburetor.

The adjustment on carburetors with external diaphragms is on the link to the choke, which has a U-bend in it. Decreasing the bend lengthens the link and reduces the choke opening. Increasing the bend shortens the link and increases the choke opening. Just disconnect the link and make the appropriate bends with your fingers at the "U."

On in-carburetor coil chokes, there is a



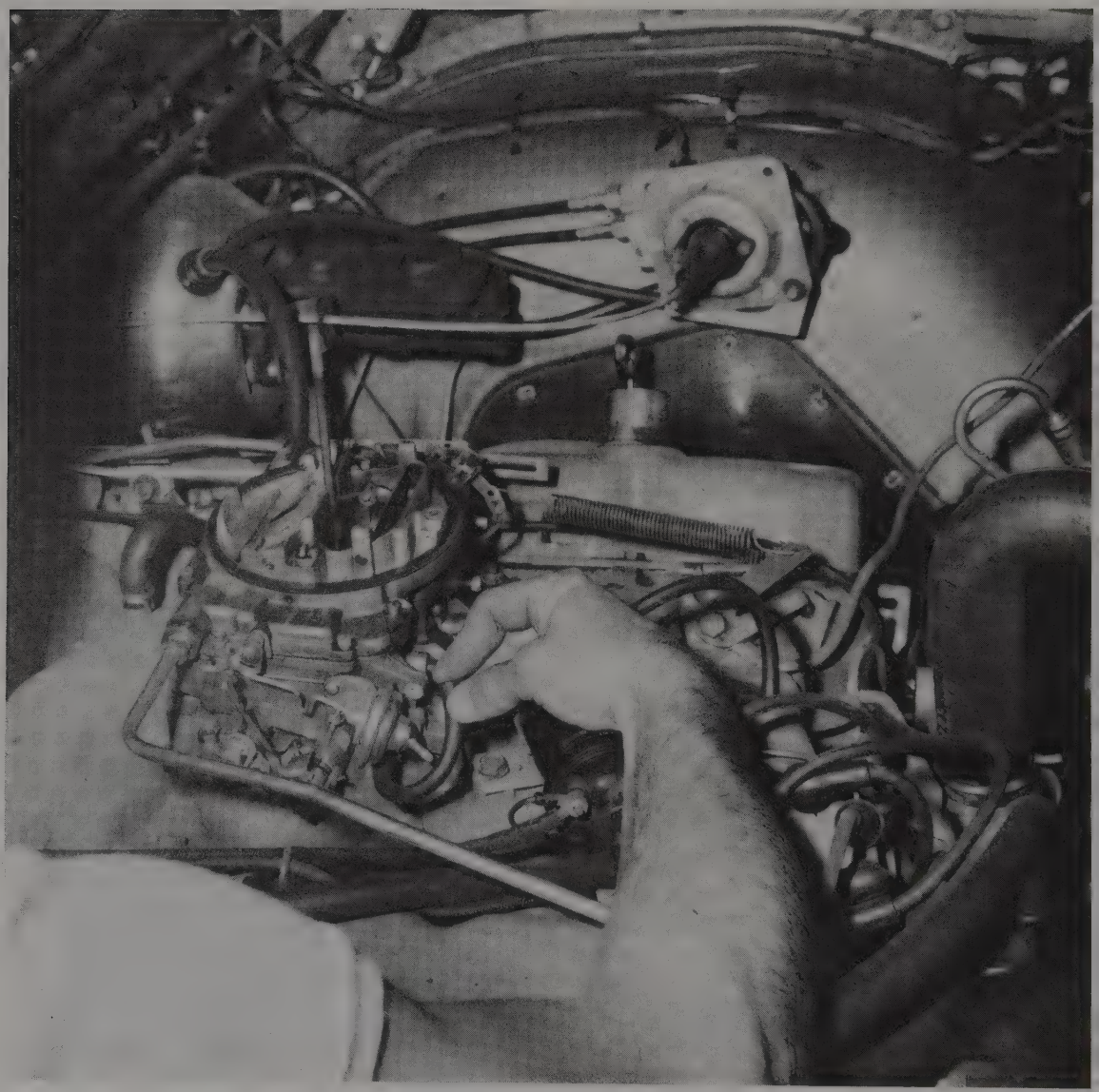
▲ *Rod slides out of well choke thermostatic coil. On cars so equipped, you could bend rod to change adjustment, but if choke coil is weak, it must be replaced.*

▲ *On Chrysler products, you can loosen nut and adjust coil tension. "L" means lean, "R" means rich, and refers to mixture.*

link from the choke plate shaft down to the thermostatic coil housing in which the vacuum piston is located. This link will normally have some form of threaded swivel on it to effectively change the length of the link. Lengthening the link reduces choke opening; shortening the link increases it.

Some Ford products with a water-heated choke (you will see the hoses going into it) have an internal diaphragm choke. On this design, there is a diaphragm housing on the side of the choke and an adjusting screw (normally with a cap over it). To adjust this design, remove the cap and turn the adjusting screw in or out as required. P.W.

See also: CARBURETORS.



▲ *Checking vacuum action with engine idling and vacuum hose disconnected from choke vacuum diaphragm.*

Adding a Circuit

Increased demand caused by more appliances can be supplied by tapping reserve power

THE ELECTRIC SERVICE in many homes was planned for future expansion of the branch system and not all the circuits that could be used were installed. Where this is the case, you can tap off additional circuits to handle the load of newly purchased appliances.

A quick look at your main circuit panel will tell you whether there is reserve power that can be utilized. If there are any empty fuse sockets, that means that those terminals in the box are not in use, either because no wiring has been connected to those terminals, or there is a "dead" circuit that's been abandoned.

Also, look to see if there is a burned-out fuse in any of the sockets, because it is possible that an "empty" was covered that way. You can distinguish a burned fuse visually by the blackened color under the glass, and the fact that the thermal strip inside has parted or burned away.

Another way to check for unused circuits is to count the number of circuit cables entering the sides of the box (in addition to the power feed cable from the main switch) and compare with the number of fuses or circuit breakers.

You may find that the box has provision for 12 circuits, but only 10 cables enter the box. Unless they are already taken by three-wire circuits, two additional branches can be tapped. This is based on the assumption that the right size panel box was installed originally, conforming to local power company or R.E.A. (Rural Electrification Administration) requirements.

Parts of the system. Before coming to conclusions about the possibility of having additional circuits, you should know the arrangements and parts of the electric system. The service entrance is the power feed from the utility company which may come into your house through overhead wires, or through underground conduit in some cities.

The utility company lines end at the meter. From there on, the system is part of the house. Wires from the meter may go through a separate main switch box which also contains a main fuse that is of the correct ampere rating for that service.

Then the power lines go into the circuit box, sometimes called the fuse panel, or cabinet. In modern installations, the main switch and fuse are part of the circuit box, so the separate switch and fuse box are eliminated. The circuit box has a number of fuse sockets or circuit breakers, each intended to serve an individual branch circuit.

A 60-amp. box has from four to six fuses, while a 10-amp. service has from eight to twelve fuses. Homes with electric ranges and electric water heater may have 150- or 200-amp. service, with up to 24 circuits.

Another factor determining the total number of branches is the "size" of the circuits, or rather the purpose for which

circular saw: see tools

To add extra circuits to your present system install a four-fuse sub-panel that can be attached to the main cabinet.

they are used, whether for lights and small appliances, or for major appliances and heaters that draw considerably more wattage.

With these considerations in mind, you can tell whether there is room for putting extra circuits into the panel. If there is any doubt in your mind, get in touch with the utility company which has a record of the type of service installed at your house.

Adding a fuse cabinet. The wiring in your home may have been badly planned to begin with, resulting in inefficient distribution of the power. There may be only one circuit in the kitchen where there are a number of appliances. In addition to the refrigerator, some of them simultaneously are in use like a toaster and skillet, while other circuits to the bedrooms are used only for a few lights. You could correct this to some extent by redistributing the load with an extra circuit if it is installed in conformity with National Code standards and local ordinances.

The new circuit won't add a bit to your total electric capacity, but can help prevent special overloaded situations. In the above case, a separate circuit for the refrigerator may make the present wiring in the kitchen more reliable, prevent blowing of fuses.

If there are just six fuse plugs, and all are in use, you will need an extra box for the additional branch. A small box for surface mounting, with two fuse plugs, should be purchased. This is called a sub-panel.

The switch panel and sub-panel should be close together and joined with a short pipe nipple through knockout holes at the sides. The wires run from the switch panel through the nipple to the fuse lugs and the circuit wires connected at the terminals.

Mounting the box. The sub-panel box must be separately attached to the wall, or to the same board that holds the main panel. Pry out the knockouts in both boxes, get a pipe nipple to fit the opening and long enough so there is about ½-inch of thread on the inside of each box.

Usually, there is ample clearance inside the boxes, but check on this first to select the best knockout position in the main box so the nipple can be easily joined on the inside with a locknut. Remember to use bushings on the nipple threads. Avoid making any extra holes in the box beyond the ones needed for the actual connection. Strip the enamel on the box around the holes so there will be good ground contact for the nipple locknuts.

When the box is mounted, shut off the power by pulling the main fuse. This may be the blade type, held in copper spring catches, and can be gripped at the center and pulled out. As a safety measure, it's a good idea to stand on a rubber mat or wood plank and avoid touching anything with the other hand.

Use #12 wire for an appliance circuit. Measure the wire beforehand to correct length and strip the ends.

Making connections. When the boxes are solidly joined with the nipple, slip the wires through. First connect them to the fuse lugs, then make the connection in the main box. The terminal connections are just as simple as any other, except that utmost care should be exercised to get the wires on the correct lugs. That is, the white wire on the

common ground (neutral) side, and black wire on the "hot" side.

Also, avoid changing the wires of the existing circuits in the box, and be sure not to touch the service entrance wires if the main fuse is in the same box, as they would be "live" even though the fuse is pulled. Go over the terminal connections to make sure they are tight.

Replace the panel cover and turn the main switch back on. The fuse plugs in the new box now have current and are ready for connecting the new circuits. If you want to test them, just screw a light bulb into the sockets. Don't leave the sockets empty, but rather put in burned out fuses right away.

For connecting an appliance circuit use #12 cable. Make the outlet box installation first, working back toward the fuse box. This is the general practice in almost all electrical work. Connect the wires into the appliance outlet box, then run the cable back to the panel box. If possible, use a continuous run of cable without splices.

At the fuse box, with power shut off, bring the cable through a knockout opening, lock it in tightly with a connector, and make the connections to the terminal lugs. Replacing the fuse and turning on the main switch puts the circuit into service.

Snaking wires. The big task in circuit wiring is getting the cable to the final location. That's easy enough when connecting an outlet in the basement laundry room for a washing machine, as the location is probably not far from the fuse box and there is no need for concealed wiring. Even appliance wiring for a kitchen is usually without complications because the cable is simply brought up through the basement ceiling behind the wall cabinet or the sink.

But it's a different matter when bringing wires to an upstairs bedroom for an air conditioner or to the living room or den where there can be no breaking of walls.

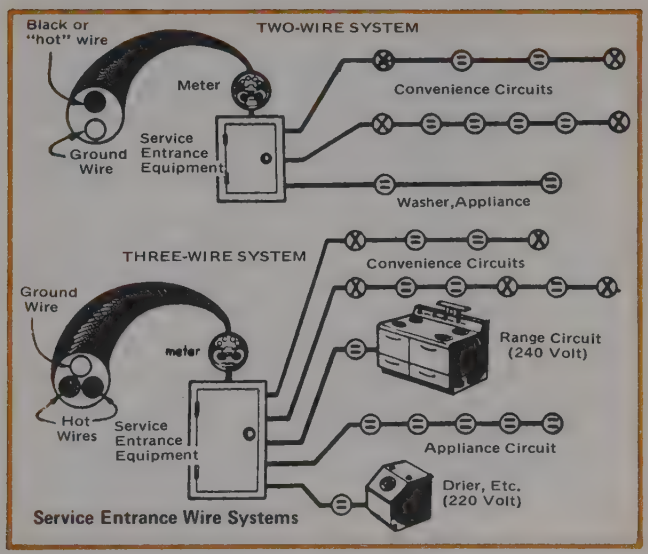
The basic technique is snaking wires through the walls, or wherever there is the slightest opening. Cables can be brought from the basement all the way to the attic for a cooling fan, by fishing it up along the the plumbing soil stack.

A fish tape is the chief tool in the electricians' bag of tricks. Also known as a snake, it is used to find the trail and pull wires inside walls, through floors, along the joists, and through long runs of conduit.

This tape is a tempered flat steel wire, $\frac{1}{16}$ x $\frac{1}{8}$-inch, comes in coils of 50, 75 and 100-foot lengths, and is sold at electrical supply stores. Ordinary steel baling wire sometimes is a satisfactory substitute, though it lacks the springy temper and stiffness that straightens out the tape after it hits an obstruction.

Before using the tape, make a loop at the tip so the wire won't snag, and to form an eye for threading the cable wires. As the tempered steel may snap when bent, the end should be heated red hot with a torch or over a gas stove. Some tapes come with a knob at the end for use with a special "eye ball."

A drill bit extension is also valuable for drilling through from floor-to-floor, or where there is unusual thickness. A bit extension is 12, 18 or 24 inches long, with a



square chuck at one end for clamping the bit shank. The other end is fitted into a standard drill brace.

Because the extension chuck is ⅝-inch diameter at its largest part, the bit used with it must be at least 1/16-inch larger to permit the extension to follow through in the hole. This extension is sold at hardware stores.

Fishing tricks. Fishing for an opening inside walls is slow work and may exhaust your patience unless you know there's a good chance to get through. The "light test" gives encouragement to keep at it. For example, if you need to push the snake a long way between beams, place a drop lamp or flashlight at the far end of the run; a glimmer of light at your end is a sign that the way is clear.

When the tape is stuck because of a sharp bend in the wall or other obstruction, it sometimes can be brought in by sending a second tape from the other end to help pull it through. One of the wires is rotated while it is moved back and forth until both hooks catch, then one tape is pulled back carefully, bringing the other with it.

If the snake is blocked by a "cat" or header in the wall, the position of the obstruction is found by sticking a bit of electrical tape on the snake at the point where it enters the wall opening. Measuring the length from the marker to the end of the snake will show where to cut into the wall and notch out the header to clear the way.

Make a safe tie. When the tape reaches its objective, it must pull the wire cable after it. There may be tough going around curves and through small openings, so the cable must be securely fastened.

Strip about 12 inches of armor off the cable to expose the wires. Both wires go part way through the tape hook or eye. Bend one wire back and wind it tightly around the other cable wires, then bend the others so they can be turned around the steel tape. Another way is to separate the cable wires, putting one through the tape hook from one side, the other wire from the opposite side. Then bend both wires back and wind them tightly around the pair of wires. For extra security, bind the tie with electrical tape.

Fishing holes should be located, when possible, behind baseboards and moldings, and inside closets. Small holes are punched in room walls and ceiling only as a last resort and then damage is minimized.

For example, if the wall is papered, the section of wallpaper is peeled back so it can cover the patch later. To do this, make several slits with a razor blade, then moisten the paper with a sponge until it softens and can be peeled back. Ceiling holes are easy to patch. The paint usually is white, or a light color that can be matched. At the very worst, painting of an entire ceiling is simple.

A valuable "coverup" scheme is to place a new outlet at the location of a fishing hole. The opening is planned at a logical place for the outlet, which will be part of the new circuit wiring. This method helps also to simplify the installation, as the outlet serves as a splice box and thus, a shorter stretch of the cable need be used from the circuit box.

The new outlet also offers opportunity to distribute the circuit for additional purposes. This outlet connection should meet the requirement that cable splice boxes be solidly mounted and always accessible.

Additional ways to bring cable across a room are under the floor and along the basement ceiling (in a one-story house), or between the floor beams, if they run in the right direction. In the first method, holes are drilled up from the basement through the floor plates at both receptacle locations. The cable then is run underneath between both points.

Running the cable across the floor joists is a bit more tricky, as this requires lifting a length of finish flooring, by slicing the

tongue at both sides, with a three-inch flooring chisel. A narrow strip of sub-floor can be cut with a portable saw to recess the cable.

Second story job. One way to get a new circuit cable to a second-story bedroom is to start from the top—that is, up in the attic alongside a vertical plumbing line, such as the vent stack. House framing and flooring do not fit closely at such installations, so there's a chance to snake all the way through to the basement. This takes patient fishing, but is frequently successful.

Once the tape gets through, pull the cable all the way up to the attic, then lower it inside the wall to the floor below through a hole in the top framing plate, and fish it out through the new outlet opening.

The standard procedure for bringing cable floor-to-floor is to drill inside the wall.

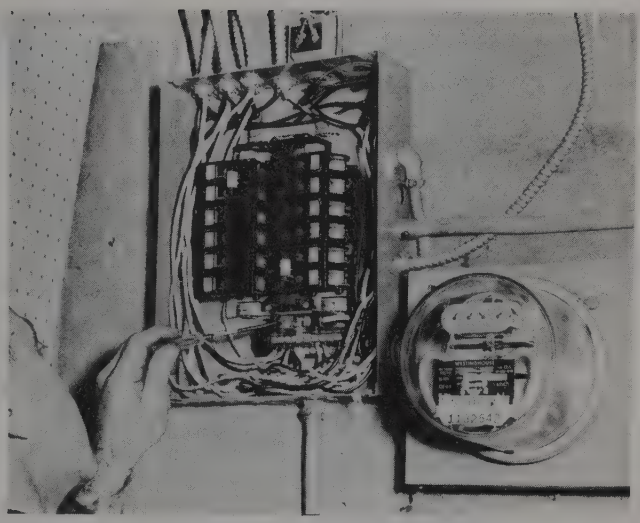
Directly below the second-floor opening, drill up from the basement into the first floor plate. Now push a snake up from below, and send another down from the second floor.

This is a long-shot chance, but the tapes must stay within the narrow area between two studs and if one of them loops over, the other hook will slip under it and ride along until the ends meet and hook together.

If repeated efforts fail, the situation is solved by opening a hole for an extra outlet. A cable through the bottom hole is spliced inside the outlet box, from which a second cable is easily brought upstairs.

A chief obstacle may be a header in the wall frame. The choice then is to shift operations to the next stud, which may be clear, or to open a hole and notch the header.

An alternative method for reaching the upper floor, particularly for homes with metal lath or solid walls, is to bring the weatherproof wires outside the house, through rigid conduit. The conduit is passed outside a hole drilled in the exterior wall above the foundation sill, then bent in the upper story. Bending is done with a hickey.

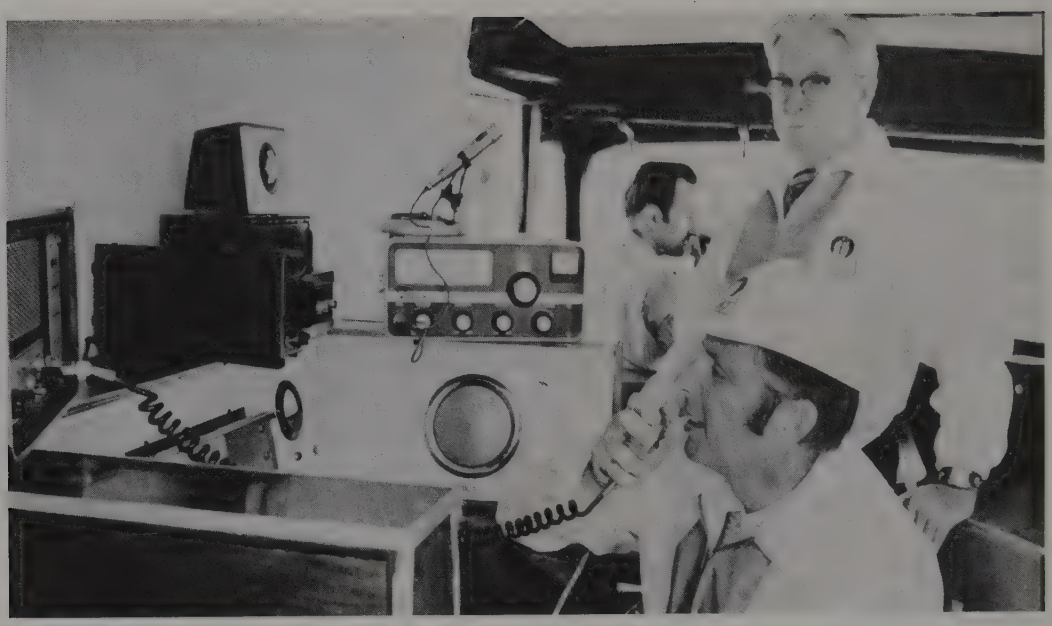


Use utmost care when connecting wires to fuse lugs making sure they are attached to the right terminal.

One place to consider snaking the fish tape is between studs where an opening sometimes exists.

Conduit is available in 10-foot lengths, and joined with couplings. The wall openings must be properly caulked and conduit securely strapped to the wall. Pull the wires through with a snake after the conduit is installed.

See also: ELECTRICITY.



All about Citizen's Band Radio

How to choose and install this easy-to-operate radio system in your car, home or office

ANY CITIZEN over the age of 18 became entitled to operate his own radio system in 1958. For the first time in broadcasting's history, any citizen could transmit and receive messages with his radio system to communicate with operators of other similar systems—and without the need for a great deal of technical training.

CB radio is put to almost every conceivable use, from rescue team message to small business and family communications message—many realized that just the sheer quantity of non-governmental controlled radios offered the potential for a *national emergency service*. Now anyone could send out a call for a helping hand—whether for a flat tire on a lonely road, or for a life-saving ambulance in time of disaster.

For CB's first five years of existence, emergency service was relegated mainly to local, or area, network operation. Some CBers banded together into emergency service teams, informally assigning various channels for distress frequency monitoring. Others took out time to monitor channel 9 (or 11), listening for "distress" calls.

The FCC officially cleared Channel 9 of all CB chitchat. Channel 9 was reserved exclusively for emergency calls. It only serves the citizen in distress—only he can originate a call on Channel 9.

Something for everybody. CB radio has

clamps: see hand tools
cleaners, air: see air cleaners
clock radio: see radio

many applications. In fact anyone who has a need to talk to someone else (locally, of course) where no telephone is available, can use CB.

From a personal standpoint, you can put a set in your car and one in your house and have instant communications with your family while you are on the road. You can call when you get tied up in traffic and will be late for supper. You can be asked to pick up something from the store on the way home. You can probably think up many other similar uses along these lines.

The set in your car will also be useful when taking a motor trip because it may be used to make reservations at many CB equipped motels, hotels, and restaurants. You can use it to ask for road instructions and directions, and (in many areas of the country) it may be used to summon emergency aid if you have trouble with the car.

A set on your boat will permit you to have communications aboard at a fraction of the cost you would have to spend for regular marine-band 2-way radio. If you use it to communicate with your home, you save the cost of ship-to-shore calls. Many Coast Guard Auxiliary units, marinas, and *boatels* monitor CB for emergency communications and reservations.

How far the signal? While this may sound like a fairy tale come true, CB does have its limitations, and range is one of them. It's very difficult to draw any hard and fast rules regarding the range of CB equipment because so many variable factors contribute to coverage. It does not offer the same range of telephone company mobile telephone service.

As an average, most CB'ers in cities get reliable results of 10-12 miles between mobile and base (17-20 miles in country), 7-10 miles between two mobile units (12-15 in country), and 20 miles between base stations (25 to 30 in country). As mentioned, there are great variances, and some CB base stations communicate reliably over ranges of 50 to 75 miles. Useful ranges have been increased by SSB (single sideband) equipment that cuts through the hash. SSB gear, though not new, has made great inroads into the CB area because of its increased reliability, it limits channel clutter, and effectively doubles the communication channels available. Also, your antenna has a lot to do with it.

Shipboard stations get an extra bonus, as CB signals travel over water with less loss of strength than when they have to penetrate buildings, trees, and other obstructions. Add two or three to each of the foregoing "country" distance estimates when using your CB equipment on the water.

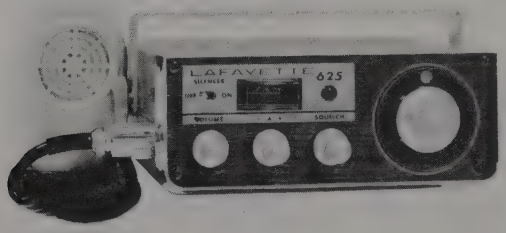
No test? There is no test necessary to get you going as a CB'er, but you do have to obtain a license from the FCC. This, at one time, meant a lengthy form which had to be signed in front of a notary public. Today, the license form (FCC Form 505) consists of a few brief questions and the signature does not have to be notarized. Any U. S. citizen, 18 or older may apply. Any unlicensed person of any age may operate a unit with permission from the licensee.

The license costs $20 and takes about three to four weeks to process, at which time you will receive a CB callsign for your station. One license and callsign will be used for all of the CB units licensed to you, it is not necessary to obtain a different license for equipment in your home and car, for instance. Several dozen units might be covered under one license and callsign, although the usual number for a non-commercial licensee is less than seven units.

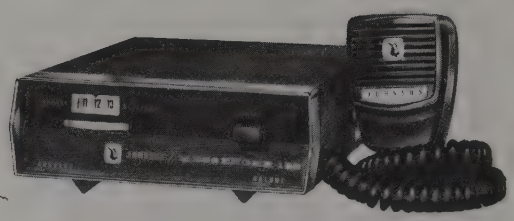
Your license will be in your hands soon. In the meantime, it would be a good idea to read all about CB. Then you will be ready to shop for your first CB rig.

Picking CB gear. The big question, of course, is "What is the very best CB rig I can buy?" And, quite naturally, you'll want a big answer. But, actually, there is no cut

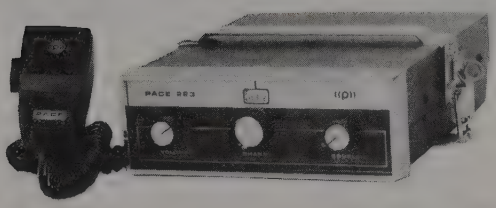
These CB radio transceivers are designed for mobile service. A six-channel set ordinarily will serve for home-auto communications unless you live in an area of high CB activity, in which case choose a 23-channel set.



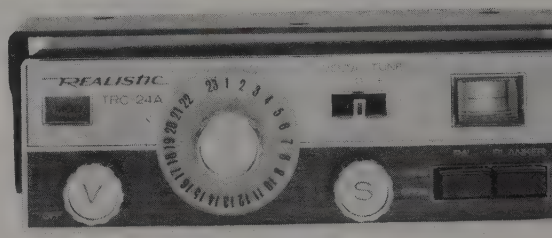
Lafayette 625



E. F. Johnson Messenger 122



Pace 223



Realistic TRC-24A

Pierce-Simpson Cougar 23

and dry answer to such a question on a general basis. Selecting the "best" from among the "good" will depend on your specific needs.

Selectivity. Channel crowding means that one of the prime considerations when looking at the receiving capabilities of a transceiver is to check its selectivity. Selectivity is, as the name implies, the ability of the piece of equipment to select for your ears only those signals on the specific channel to which you are tuned, rejecting those on adjacent channels. Receivers with poor selectivity may hear as many as three channels at once. If you happen to live in an area where CB activity is high you'll find that extracting the desired signal from a channel is rough enough at times, and trying to pull it out from under three-channels' worth of chatter is nearly impossible. Selectivity also means the ability of the receiver to reject unwanted "image" signals.

Selectivity is certainly one of the major cost factors in any CB rig, and you can be sure that a low-priced, bargain set is going to be as selective as the proverbial "wide open barn door." If you live out in the

country where CB activity is relatively low you may not find that selectivity is as important as someone who lives in a high-activity area. You may be able to buy more for your CB dollar by purchasing a set with fair selectivity should you decide it's all right.

Sensitivity. Sensitivity is the ability of the CB rig to pick up weak stations. Since the sensitivity circuits are the first things which the incoming signal encounters in your rig, they are commonly known as the *front end.*

Sensitivity ratings are given in microvolts (uV) on a CB spec sheet, and usually the lower the rating figure, the more sensitive the receiver.

Noise limiting. A popular noise limiter in CB units is the so-called *series-gate* circuit, which does a most effective job. One minor difference in various sets is whether or not you can switch the noise limiter in and out of the receiver circuit, or whether it is always functioning. Don't reject a set if you can't switch on the noise limiter; it's probably an automatic type that adjusts itself according to signal conditions.

One innovation to arrive on the CB scene is the *noise silencer circuit,* which is an advanced and sophisticated type of noise limiter. Its specialty is crushing impulse type noises, such as are created by motors. Since it isn't completely effective on continuous-type noise, it is usually supplemented by a second limiter. One rig, for example, has a switch which allows you to switch to standard noise limiting or a noise silencer. You'll see a lot of SSB rigs and some quality AM jobs using the *noise silencer* circuit.

Receiver tuning. There are two types of receiver tuning: fixed (or crystal controlled) and tunable, like your table radio. Many sets have both of these features. Sets having a combination fixed and tunable receiver are good in at least one respect. They permit you to save some money since you need only purchase transmitting crystals and use the tunable receiver to operate on channels you didn't ordinarily require. You will find that this will be a nuisance, however, unless the rig has a crystal spotting circuit. This circuit, controlled by a push-button on the front panel, allows you to locate your transmitting frequency (channel) on the tunable receiver's dial in a jiffy. Otherwise, tuning around for a specific channel can be quite trying because (in a great many units) the channel dial marks aren't accurate; or they tend to change as the receiver warms up and drifts. But then you need transmit crystals for spotting.

In CB rigs having a frequency synthesis circuit, you will have a 23-channel fixed-tuned receiver, thus eliminating the need for a tunable receiver. If you're going to be a channel hopper, this is the rig for you.

Delta tuning is a feature in some fixed tuned receivers. It is more or less a *fine tuning* knob, such as on a TV set. This permits you to zero in on another station which might be transmitting slightly above or below the exact center of the CB channel. This feature is especially handy to have on receivers having high selectivity. You really need it on SSB rigs.

Transmitters. The transmitter portion of CB rigs are almost all rated at five watts *input* which is the maximum power permitted under the present FCC rules. The actual output is always lower than five watts, as 100% efficiency in a transmitter is impossible to achieve. The average efficiency is about 60 to 70%, and most rigs will therefore put out 3 to 3.5 watts. The actual on-the-air difference between transceivers running 2.5 to 3.5 watts (providing they are equal in most other features) will be almost indistinguishable.

The big difference in the transmitter is actually to be found in the modulation, or audio, section. Since FCC rules limit the amount of modulation a CB station may use to 100%, there are ways which have

been found to achieve *big talk* without overmodulating.

Many transceivers incorporate this circuitry under names such as "range boost," "speech clipping," "compression," "limiting," or "audio preamplification." Each works its own special way, but the end result is to make you sound as loud as possible within the limits of the FCC rules.

Other than AM. One of the more recent things to be hawked by CB manufacturers is the *sideband* method of modulation, this includes *double sideband* (DSB) and *single sideband* (SSB). Both methods have been around radio for a number of years, each having created its own minor sensation upon impact in the various corners of the radio world.

When single sideband became a commercially feasible method of radio communication, it was snapped up as *the* modulation system to use. Why not? Compared with standard amplitude modulation, SSB offered a means of extending your communications range without increasing the power of the transmitter. Ham operators quickly jumped onto the SSB bandwagon. It was snapped up by all international radiotelephone services; even the military services converted a large portion of their operations to this method of communication. The Citizens Radio Service was lost in the shuffle for some time and only recently has it become the rage. Why such a valuable communications tool has been ignored by manufacturers and CBers alike for so many years may be never known. The current use of SSB for the CB service by many CBers has accomplished the following for them: it doubled the number of available channels; it greatly increased the communications range of their five-watt transmitters (it will, in fact, more than triple their wattage performance).

So, one day in the mid-'60's a manufacturer said to himself, "I think that my company will bring out a SSB transceiver for CB." He then had his engineering department whip together just such a device. It was nice too! Only one trouble, *nobody bought them.*

About that time, several rigs employing DSB were brought onto the market. While not equalling the commercial disaster of the SSB unit, they also proved to be a disappointment—CB'ers just didn't buy them.

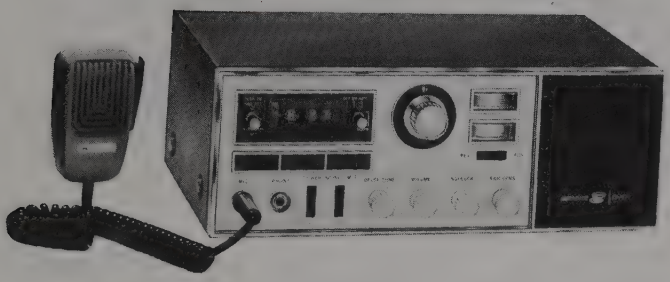
Some manufacturers and CB'ers were questioned at that time as to what might be the reason for the failure of SSB to catch hold. CB users, for the most part, seemed to agree that it certainly would solve a lot of problems but that it had the drawback of not being compatible with existing CB equipment.

From the manufacturers' point of view, SSB equipment costs considerably more to produce than does a regular CB rig. The transmitter and receiver must be engineered and built to very close electrical and mechanical tolerances. They must be able to lock onto a channel with incredibly low drift.

But times change and so do CBer needs. The urgent requirement for 100 per cent dependable communication initiated the switch to SSB by many serious and business users of CB. In addition, newcomers to CB went to SSB on advice of friends since they had no old gear to grow obsolete. Gradually, as rigs "expired," CB oldtimers made the switch to SSB and the boom for SSB gear is on.

Meters. The CB rig which has any meter at all probably has something called an "S-meter." This meter indicates the relative strengths of signals coming in, the meter is adjusted to show a reading of zero, then all other signals will read from 1 through 9 and in decibels over S9. Frequently combined with the S meter is a power meter (the dual function of the meter is selected by a switch on the panel). The power

Realistic TRC 23B



Midland 13-877

Pierce-Simpson Lynx 23

Pierce-Simpson Bearcat 23

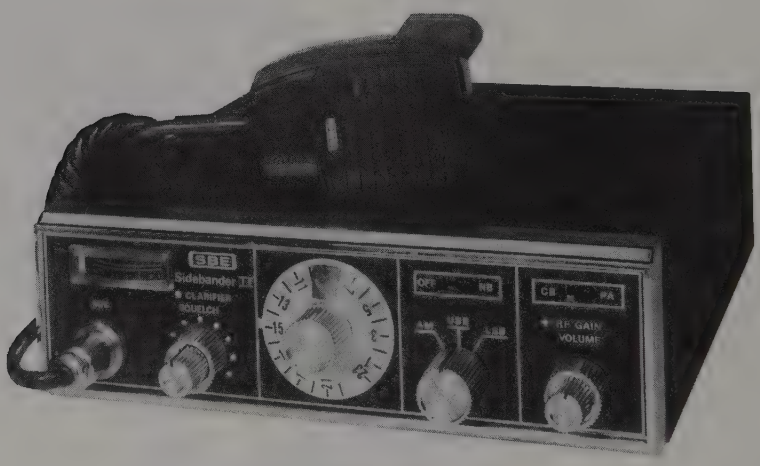
meter shows the *relative strength* of your own transmitter, when it reads maximum you know that your transmitter is operating at top efficiency. The S-meter is a handy accessory, not only in daily operation, but for trouble-shooting.

Other features. Just about all CB transceivers incorporate a *squelch* circuit. This circuit enables you to set the receiver so that *no* background noise or static are heard when no station is transmitting on the channel to which the equipment is tuned. There is dead silence but anybody coming on the channel will instantly bring your equipment to life and the station will be heard normally. The squelch circuits in different sets are of different quality, but a good one will not "open up" for sudden bursts of static, as will poor ones. The squelch can be adjusted for sensitivity levels, even to the point where it will keep your set quiet for all but very strong local signals.

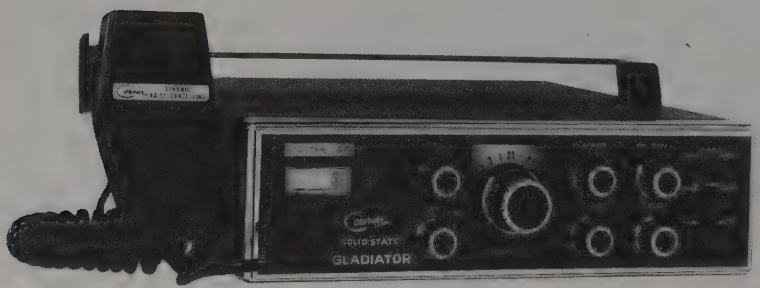
CB sets have built-in low-pass filters to screen out certain types of television interference. While this doesn't seem to be a vital factor in mobile operation, if the set you choose for a base station does not have an adequate filter, you may have to purchase an external filter.

CB base station. Any CB station located at a permanent or temporary fixed location is known as a "base station." The purpose of a base station is to communicate with other base stations and mobile units. How well you accomplish this will depend upon your installation.

The installation consists of the location

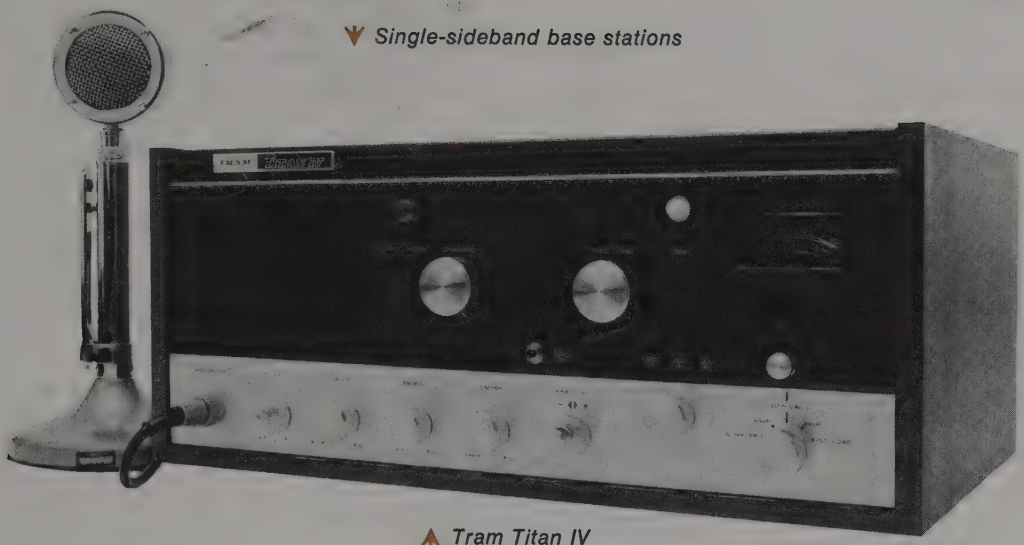


SBD Sidebander II

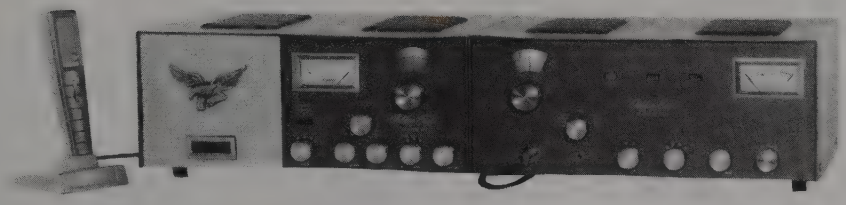


Courier Gladiator

Single-sideband base stations



Tram Titan IV



Browning Golden Eagle Mark III

of the equipment in your shack (all radio rooms are known as "shacks" in CB), the manner in which the equipment is "hooked up," and the way it is serviced and maintained.

The equipment you will want to select for your base station will have a 110-volt AC power supply (some transceivers designed primarily for mobile use operate on 6 or 12 volts only, and must have an extra power supply in order to operate on house current). You will also find that a desk-type microphone with a push-bar (as opposed to a hand-held push-button mike) will make for ease of operation; however, desk mikes aren't normally sold with a CB transceiver. Such mikes are available as accessories and may be purchased at a later date.

Do-it-yourself. Customized installations are also nice for someone who is handy with tools and wood. Some beautiful work has been done by CBers along these lines. In addition to simply building elaborate cabinet enclosures and desks, some operators who are also technically proficient in the finer points of electronics, have redesigned their transceivers from front to back, improving some circuits, adding others.

Locate the installation where you will be able to run the antenna cable out of the window conveniently and without making a ridge down the center of your carpet. Just as the heat from the stove won't help the situation, radiators will also not aid in extending the life of a transceiver. CB rigs have components which can deteriorate under excessive heat.

You will probably find it handy to have a telephone on your desk. Posted near the telephone keep the telephone numbers of police, fire, and other emergency numbers.

Other handy things for a CB desk are a lamp (try *not* to use fluorescent lamps as they tend to create noise in the CB receiver), a pencil sharpener, a digital reading clock, a five-minute timer and a map of the city.

Safety precautions should always be observed. Bond all metal cabinets together by hooking them to a cold-water pipe ground with heavy #12 copper wire. You may find that it is best to run a single, well-insulated, heavy-duty cord from the outlet to a multiple outlet tap attached to the side or back of the operating table rather than running long wires from the outlet to everything on the table. Do not overload your house circuits.

The hook-up. While the location of the antenna on your roof will be a matter of your own personal taste and will be limited in height by FCC regulations, getting the signal to and from the antenna will be a universal problem regardless of what type of antenna you use and where it is located.

Getting the signal between the CB rig and the antenna means the use of lead-in wire, and in CB, this is coaxial cable. There are many types of coaxial cable sold, and most CB antenna are designed for use with cable having an impedance of 50 ohms. Because of the fact that coaxial cable creates losses in signal strength (both incoming and outgoing), your best bet is to select for your use only those cables which will give best results, using as short a length as possible.

For short runs, 50 feet or less, you can use RG-58A/U cable. Longer runs call for RG-8A/U. When buying cable, stick to those with the "A/U" in the type number as they will perform better and last longer than those without this designation, although the other cables (without the "A/U") will be less expensive. For the very top performance, you can use low loss "polyfoam" type cable which can result in a signal increase (since losses are lower) of as much as 35% over standard coaxial cables.

If you are using RG-8A/U type cable you will require an Amphenol 83-1SP plug (also known as a PL-259 plug) to connect the cable to the rear of your transceiver. Most likely, you will need one to connect to the other end of the cable which goes to the antenna. Attaching these plugs to the cable is tricky and usually trying on the nerves. Solderless plugs are now available at reasonable prices and connection to the coax cable is easy.

The CB mobile station. If it's a CB rig with wheels beneath it, it's a mobile station —and it's a mobile station if it flies, sails or pedals. While it may, at first, seem a simple matter to chuck a CB rig into your car and "go mobile," there are a number of fine points to the situation which should be considered.

Mobile CBing consists of the following problems: picking the proper rig, locating and installing it, locating the antenna, and eliminating noise from the car's electrical system which also must be adequate to handle the electrical load your CB rig will impose.

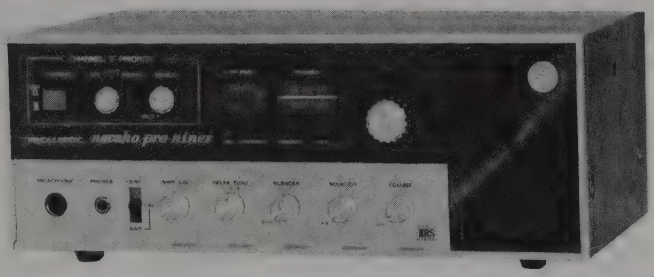
Choose the rig. Flashy chrome, snazzy modulation, meters and lights may make for great base stations, and possibly also dandy mobile rigs. The problem is that when you select a rig for mobile use, you must be a little more selective than when you are setting up a base station.

For instance, the rig must be able to fit in your car. Many of the larger rigs just can't be squeezed into Volkswagens, Fiats, Porsches, BMW, and other small cars. Select a small transistorized rig for these you say? That's fine, but some small foreign cars have positive ground type electrical systems while the majority of transistorized

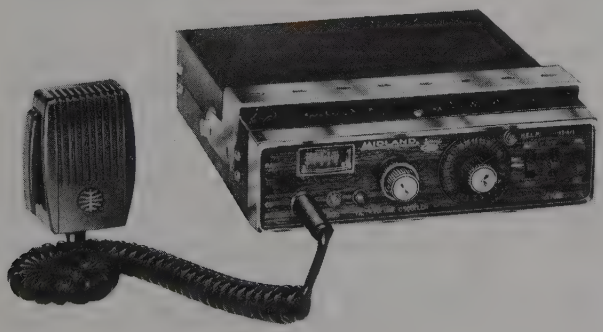
These CB transceivers are equipped to scan channel 9, the emergency channel, and alert the operator if a signal is received; they will automatically switch the set to that channel.

Dynascan Cobra 20

E. F. Johnson Messenger 323-M



Realistic TRC-49



Midland 13-871

rigs work only on negative ground systems. Then there's the little problem of the fact that many foreign cars have six-volt electrical systems, while not too many CB rigs are made for six volts any more (since all American cars have 12-volt systems these days). Anyway, that's a sampling of the problems which hit you right off the bat.

Presuming you have what most people have, a recent Detroit model, you will be able to select any 12-volt transistor rig. The only limitations will be size and price.

Foreign standard size cars will have to be checked for their electrical systems. Some transistor sets will also work on either polarity, but they must be connected to the electrical system with care and per the manufacturer's instructions so as not to damage the circuit of the CB rig. Of course, six-volt cars call for six-volt rigs, and 12-volt cars, for 12-volt rigs.

When selecting your rig, then, make a list of your car's electrical characteristics. Then check the car for possible rig mounting locations.

A standard mounting place is under the dashboard, dead center. If your car has a console or large transmission hump in this area, you may have to figure out another location. Pick your desired spot, then measure it with a ruler for available depth, width, height. When shopping for your rig, take the list with you. It will eliminate some sets.

Also eliminating certain sets will be the following factors: price, external appearance, reputation. When you have chipped away at the mass of sets with the foregoing tests you can then narrow down the group even more.

What are your needs? Can you get by on a set offering only a few channels, or do you want to cover all 23 channels? Are you in an area of high CB activity where you require sharp selectivity, or can you get by on one with relatively broad tuning? Will communications be over long distances where speech compression is required for extra talk power, or can you make do with standard unadorned modulation?

Even after you make all of the remaining rigs jump over these hurdles, or fall by the wayside, you will still have quite a few sets from which to choose. From here on in, it's a matter of picking the set because of any particular outstanding feature, or because someone you know has one like it.

Installing the rig. When you selected your rig you also chose the spot for it to be mounted. Presumably, it's somewhere near the driver's seat and beneath the dashboard. The mounting place for the rig will have to be where you can run the power cable to the battery and the antenna cable to the antenna.

Most CB rigs today come equipped with a mobile mounting bracket, together with all necessary hardware and complete mounting instructions. Since each rig has its own individual mounting problems and a different type of bracket, we need not go into details of the actual drilling and mounting here. Rest assured that the instructions supplied by the manufacturer will be easy to comprehend. You will need a hand electric drill, and a set of drill bits, by the way.

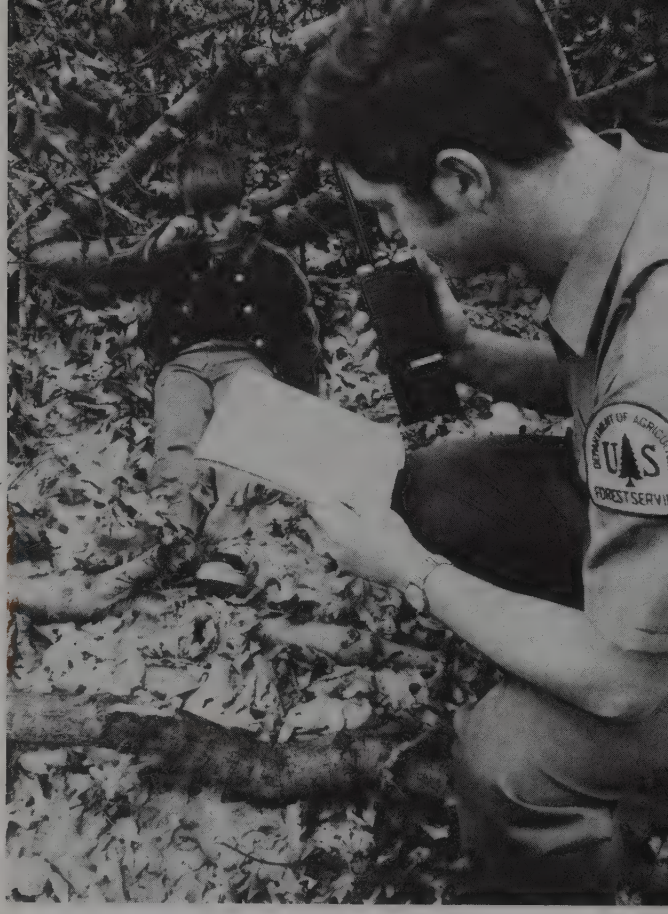
Your next step is to get the power to the CB set. First, see if the manufacturer has thoughtfully supplied you with a power cord which can be plugged into your car's cigarette lighter. He did? Good! Roll it up and toss it into your trunk! Such a gadget is to be used only in an emergency or for a *very* temporary installation.

Regardless of what you may have heard about wiring the power cable for the CB rig across the car's ignition switch, the best place to obtain the power is directly from the car's battery. You eliminate a lot of noise. In one installation, a rig produced full five-watt signal bursts with each click of the turn signal.

See also: ANTENNAS; ELECTRONICS.

How to Use CB Radio

Keep in touch by installing one of these easy-to-operate transceivers in your home, car or boat, or just by holding a walkie-talkie version in your hand



Forest ranger demonstrates how a hand-held CB transceiver would be used to report the location of a lost child. Rangers operating where rugged terrain limits operations to foot or horseback use CB walkie-talkies to communicate with home base and with each other.

YOU CAN JOIN the millions of persons in the United States who are broadcasting and receiving business and essential personal messages on citizens band (CB) radio. All you need is the equipment and a license. No radio knowledge or experience is necessary, and the $20 license is easy to obtain.

The combination transmitter/receiver sets (called transceivers) are in use in homes, automobiles, boats, airplanes, shops, even snowmobiles, and as hand-held walkie-talkies.

With all this variety, the combinations are endless: people in cars talk to people at home; people in the woods talk to people on boats; people on snowmobiles talk to people in planes, etc.

CB radio is for U. S. citizens (Canada has a similar service for Canadians). Any U. S. citizen over the age of 18 is eligible for a license. To get an application, write to the Federal Communications Commission, Washington, D.C. 20554, and ask for Form 505. All you do is fill out the form and mail it along with the $20 fee to the FCC (Gettysburg, Pa. 17325). There is no examination of any kind, and no technical knowledge is required. Incidentally, a form 505 usually comes packed along with each transceiver you buy, or you can get one from the nearest FCC field station. Check your phone book.

Once your license arrives, you may communicate on the 23 assigned CB frequency channels, according to the procedures and regulations spelled out in "Part 95" of the FCC's massive rule book. Order your copy of Part 95 by sending $2 to the Government Printing Office, Washington, D.C.

20402 (when you sign your license application, you certify that you have Part 95 on hand, or have ordered it).

Some of the rules are purely technical—for example, they spell out the maximum allowable transmitter power (five watts) and the maximum height of the top of a fixed-base antenna over a house (20 feet). Other rules are procedural—such as the item that spells out the type of communication allowed on each channel. A few outright prohibitions. For example, no profane, obscene or indecent language, and all communications must have a necessary purpose.

When your license arrives, you'll probably also receive a little booklet called "How To Use CB Radio" that explains the important rules in everyday language.

Note: there was a time when some CB'ers broke every rule in the book with impunity. Those days are gone forever. The FCC has cracked down: listening posts across the country monitor the CB band. Breaking the rules can cost you your CB license, your gear, and a fat fine.

Push-to-talk. Most CB transceivers are as easy to use as a telephone: you simply flip the selector switch to the number of the channel you want, then you push the button on the microphone and start talking. Pressing the push-to-talk switch makes the transceiver operate as a transmitter; let go, and the unit turns into a receiver. You hear the other end of the conversation through a loud speaker.

The FCC doesn't expect you to sound like a highway patrolman (though lots of CB'ers like to), but there is a preferred way to call another station. Your license will include a set of call letters for your station that consists of three letters followed by four digits: KAB1234, for example. You must use these call letters to identify yourself when you call another station. For example: "KAB1234 calling KCD5678."

Nearly all base station transceivers, and most mobile transceivers, can operate on any of the 23 channels at the twist of a knob (similar to a TV channel selector). Hand-held jobs typically operate on only a few channels—you plug in specific crystals (the circuit element that controls frequency) to tune the transmitter and receiver stages to the specific channels you want to use.

At one time, all 23 channels were used for all possible purposes; now, though, different channels have been set aside for specific purposes. Channel 9 is the "emergency channel." It is specifically reserved for "emergency communications involving the immediate safety of life or protection of property, or those necessary to assist a motorist."

Channels 10 through 15, and Channel 23 can be used for communication between different licensed stations; Channels 1 through 8, and 16 through 22 can only be used by two or more units belonging to a single license holder. This means, for example, that you can call your neighbor on Channel 11 (different licensed station), but, you can talk to your wife on Channel 6 (different units belonging to a single license holder).

Incidentally, your CB station license (which includes the various transceivers you own) allows you, your employees, and members of your immediate family to use the equipment. Cousins and close friends, for example, don't qualify.

What can you do with CB? The practical applications are almost endless. To keep the FCC happy, though, your routine CB "traffic" must meet two guidelines:

1. It should be necessary communication, not idle chatter
2. Other means of communications should be impractical

In other words, if you want to chat with the girl next door, use the telephone. Save CB for valid uses such as communications from:

Your home to your car. CB provides the missing link that carries the word that you'll be late for dinner because you are stuck in traffic, or asks "Dear—please bring home a loaf of bread on your way home." Similarly, you can use CB to communicate between your office or store and your company cars or trucks.

Your car to another car. CB radio is lots better than mind reading when two cars are traveling together down a highway at high speed.

Hiker-to-campsite. Slip a walkie-talkie into your knapsack, and you'll be able to talk to the non-athletic types back in camp from miles away.

Boat-to-boat (and boat-to-shore). CB is the "poor man's ship-to-shore"; it's perfect for lake-bound boaters.

Hunter-to-hunter. CB beats shouting (and it won't spook the game). Lightweight walkie-talkies are the right rigs to carry.

Car in trouble to anyone. Here's a perfect reason to install a CB set under your car's dash. Just about two years ago, the FCC decreed that Channel 9 is only to be used for emergency communications or to aid motorists. Here's how it works.

Let's say your car breaks down in the middle of nowhere, or, you've come across an accident. You switch your CB rig to Channel 9, and say: "KAB 1234 calling anyone—this is an emergency." You'll *probably* get an answer, thanks to thousands of public spirited CB'ers who monitor Channel 9, listening for emergency calls. Many are part national organization called REACT—they belong to local REACT teams in their communities. REACT is short for Radio Emergency Associated Citizens Teams. The national headquarters is at 111 E. Wacker Drive, Chicago, Illinois 60601. They can tell you about the team in your area, in case you'd like to join.

The "motorist assistance" aspect of the FCC's Channel 9 ruling can be mighty handy when you are far from home. A call to a Channel 9 monitor can get you the best route directions, tell you where the nearest restaurant or motel is, and steer you toward your favorite brand of gas station.

▲ *Handy CB transceiver is easily mounted in an automobile.*

The operating range of CB gear depends on many factors. The most important are the power of your transmitter, the type and height of your antenna, the sensitivity of your receiver, and the nature of the terrain around you. CB is supposed to be a short-range radio service-with transmissions traveling a few miles at most, since the 23

channels are open to all users across the country, much like a mammoth party line. The FCC decrees that you shall not communicate over 150 miles (longer distances are possible-but it's illegal to try).

Actually, long-distance communications happen only if you've got ultra-elaborate (and expensive) equipment, or, if your signal "skips" off the part of the atmosphere called the ionosphere. Typical and reliable communications ranges are much shorter. For example, a full-power walkie-talkie (5-watt) is good for 10 miles or so when it's talking to a base station; mobile-to-mobile, mobile-to-base station and base station-to-base station operating range over average terrain is 15 to 20 miles, assuming everyone has a good antenna.

When selecting your rig, you can spend $50 on a CB transceiver, or you can spend $500—the difference in performance is as wide as the price range. As a rule of thumb, $150-$200 will buy you a good no-frills base station. A bit less, about $100-$130, will buy a suitable mobile unit, and $70-$100 will pay for a good full-power walkie-talkie. A base station or mobile rig will need a good external antenna, about $10-$25.

Here are a few things to keep in mind: Base station transceivers have become increasingly more elaborate in recent years. Even the cheaper units out-perform the best rigs of a few years back. The new units are likely to have many frills, even built-in electric clocks and fancy panel lighting and little signs that light up and announce "ON THE AIR." If you want the frills, fine; if not, an excellent alternative is to buy a good mobile-type transceiver (which is probably designed to be powered by 12-volts DC) and purchase an optional power supply (available with many sets). These transceivers are designed for under-dash mounting, and to save space, all the non-essentials are left out. For most CB applications they match the performance of the larger, more costly, base station sets.

High-power walkie-talkies (high-power means that they are three- to five-watt

CLASS D CB CHANNEL CHART

1	26.965 MHz	Units of same station only
2	26.975 MHz	Units of same station only
3	26.985 MHz	Units of same station only
	26.995 MHz	Class C radio control & 100 mw units
4	27.005 MHz	Units of same station only
5	27.015 MHz	Units of same station only
6	27.025 MHz	Units of same station only
7	27.035 MHz	Units of same station only
	27.045 MHz	Class C radio control & 100 mw units
8	27.055 MHz	Units of same station only
9	27.065 MHz	National CB calling channel/react
*10	27.075 MHz	All stations
*11	27.085 MHz	All stations
	27.095 MHz	Class C radio control & 100 mw units
*12	27.105 MHz	All stations
*13	27.115 MHz	All stations
*14	27.125 MHz	All stations
*15	27.135 MHz	All stations
	27.145 MHz	Class C radio control & 100 mw units
16	27.155 MHz	Units of same station only
17	27.165 MHz	Units of same station only
18	27.175 MHz	Units of same station only
19	27.185 MHz	Units of same station only
	27.195 MHz	Class C radio control & 100 mw units
20	27.205 MHz	Units of same station only
21	27.215 MHz	Units of same station only
22	27.225 MHz	Units of same station only
	27.235 MHz	100 mw units
	27.245 MHz	100 mw units
23	27.255 MHz	All stations/class C radio control

NOTE: 100 mw stations are unlicensed walkie-talkies, which are permitted operation on any frequency within the edges of the band, including frequencies lying between CB channels. Licensed Class D stations are not permitted to communicate with unlicensed walkie-talkies. Walkie-talkies may be licensed only if they meet the technical standards established by the FCC for Class D.

* Indicates interstation use

Service station manager communicates with repair truck via CB radio. He can also receive calls for help from stranded motorists with this device.

units) are excellent performers—within their limitations. Specifically, the built-in telescoping antennas used are much less efficient than external mobile "whip" or base-station antennas. And battery life (or time between recharges when rechargeable cells are used) is relatively short if you transmit often.

All transceivers are crystal-controlled. This means that transmitting frequency is determined by highly stable quartz crystal elements. In the most modern gear, frequency synthesizer circuits use a handful of crystals to work on all 23 channels. Older designs require 23 pairs of individual crystals (one for transmitting and receiving on each channel). Since crystals cost about $5 a pair, synthesis circuits can lower the cost of 23 channel operation.

For the most part, transmitter circuits are pretty much the same—it's easy to build a good five-watt transmitter. Much of the advanced circuit design in modern transceivers has gone into improving the receiver stages. Double-conversion receivers have tandem stages for amplifying and filtering the weak incoming signal—single-conversion units are less expensive (the tuners in your TV and stereo set and car radio are all single-conversion units). Mechanical and crystal filters are devices that improve selectivity—the ability of the receiver to ignore other, unwanted signals.

"Squelch" is a feature found on most transceivers. It is a circuit within the receiver that keeps the loudspeaker silent until an actual CB signal is being received. Thus, you don't hear static and miscellaneous electrical noise.

Channel 9 Monitors are relatively new developments—they are favorites of REACT team members and other Channel 9 listeners. The monitor circuit automatically signals that someone is calling on Channel 9, even though you may be operating on another channel.

That's the CB story in a nutshell. If the CB bug hasn't bitten you yet, perhaps you ought to roll up a sleeve and give it nibbling room. You'll probably discover that a CB radio is a convenient, useful and fun thing to have. R.B.

See also: ANTENNAS; ELECTRONICS; WALKIE-TALKIE.

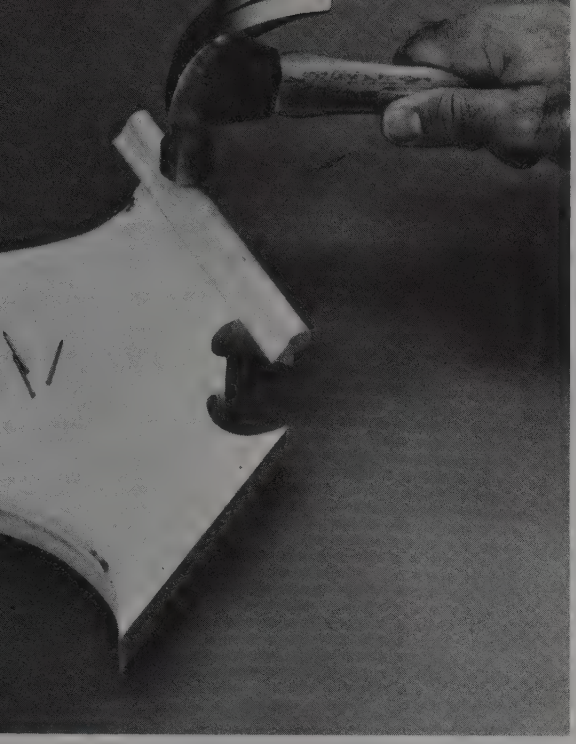
Build a Banjo Wall Clock

If it is time to replace your wall clock, try this easy-to-build Early American design with pine casing

THIS BANJO CLOCK will not play music but the pleasant sound of its battery operated movement will keep you well informed of the time. Made of pine, the case is not difficult to build. The moldings are standard and available at lumber yards. The turned finial, decorative eagle and clock works can also be purchased. Using a saber saw or jig saw, cut the outline of the clock including the rectangular cutout for the movement. Next, shape the edge with a router. If you do not have a router you can round the edges with sandpaper. We used a beading cutter but you may prefer another shape. Note that the shaping is interrupted at several points, (see drawing). Add the molding, attaching it with brads and glue. At the top, allow the ends to protrude, then trim off with a coping saw after the glue has dried. The molding at the neck is mitered. Cut the front piece first, then fit the side sections to it. To mount the finial, drill a ⅜-inch hole ¾-inch deep into the bottom. Then insert a 1½-inch length of dowel. Drill a corresponding hole into the ¼-inch platform and the top of the case. Also drill a clearance hole at the rear of the case for the hanger. The eagle was shiny bright when purchased, but it was "antiqued" by spraying it with black paint. Before the paint has a chance to dry, wipe the surface with a cloth. This will create highlights while the depressions remain dark. To mount the eagle, pierce two tiny holes with a brad, then install with escutcheons. The dial is also mounted with escutcheons.

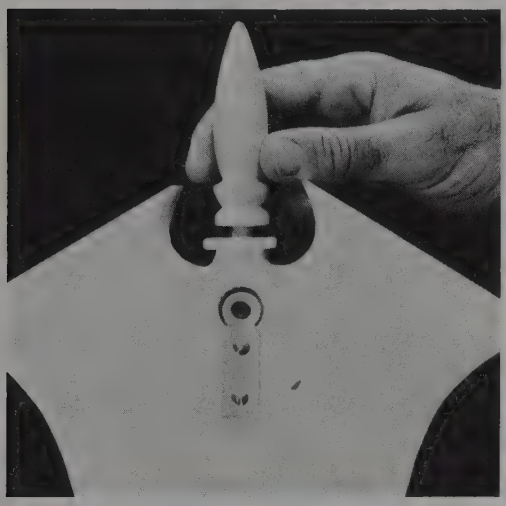
See also: FINISHING, WOOD; WOODWORKING.

clogged drains: see drains



Short lengths of nose and cove molding are nailed to the crown and then are trimmed with either coping saw or jigsaw.

Shown is the battery powered movement which is mounted directly to the dial face and which is held with shaft nut.

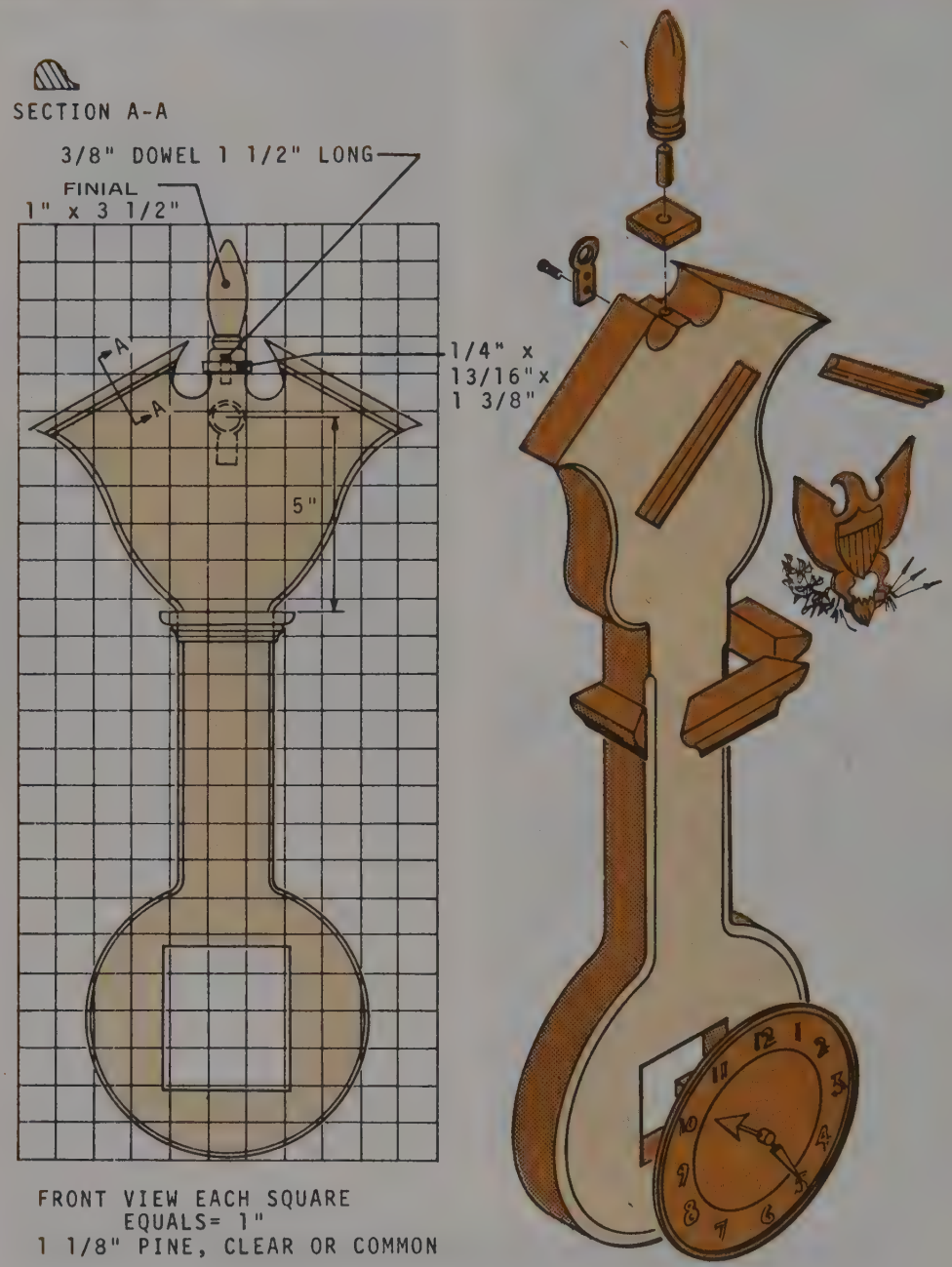


Pictured is the turned finial which completes the clock case. The hanger allows the clock to hang flush to the wall.

MATERIALS LIST

Quantity	Size and Description	Purpose
1	1⅛″ 11″x23″ pine	basic unit
1	¼″ 1″x1½″ pine	finial platform
1	¾″x2′ nose and cove molding	trim

NOTE: Also need, finial, eagle, dial, clock movement, hardware, etc.



Detailed drawing and exploded view of the banjo wall clock. Note: shaping is interrupted at several points; molding at neck is mitered.

Two Grandfathers Clocks You Can Build

Neither of these pieces of furniture are difficult to construct, so take your choice—the one with the concealed hi-fi speaker or the one without it

IF YOU HAVE wanted a grandfather's clock, but have been deterred from buying one because of the expense, try building one yourself. Either of the two designs here can be executed for less than $100. One is a plain clock and the other conceals a hi-fi speaker. Both pieces of furniture have been designed with economy and simplicity of construction in mind.

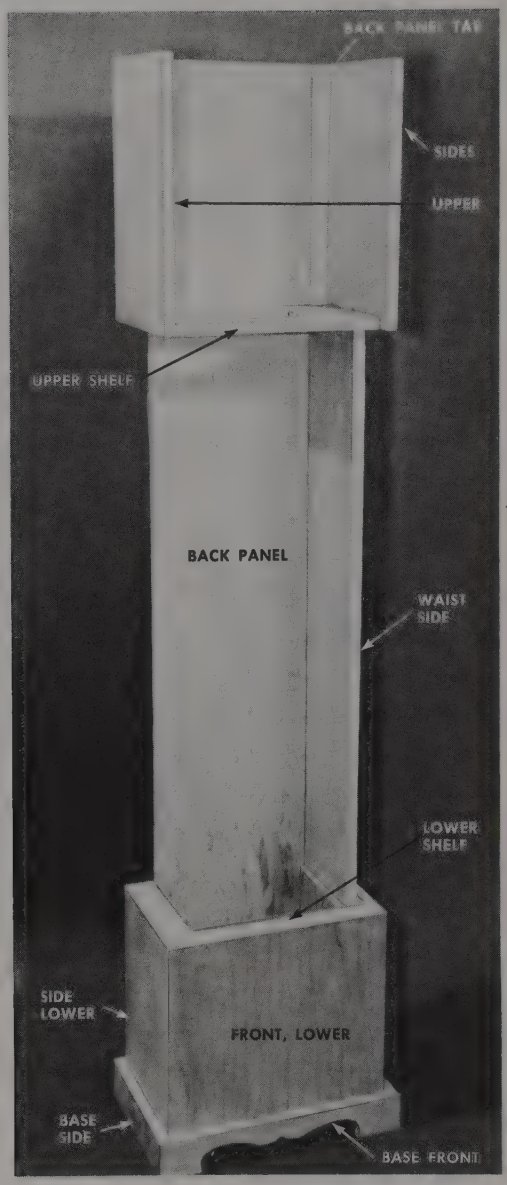
You can choose almost any kind of wood for the clocks, either solid lumber or birch, maple, pine, or mahogany plywood. The moldings are stock items found in lumber yards everywhere.

Construction of the plain clock is much simpler than it might seem from the appearance of the finished item. The major tool used is a table saw, but a router is helpful if you have one.

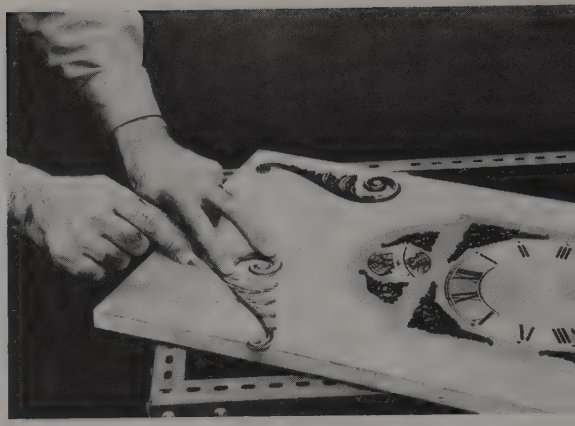
Start with the back panel, which can be considered the backbone of the clock. It is a simple rectangle that measures 10½ inches by 69 inches and it is cut from ¾-inch stock. Attach the top and bottom back panel tabs as shown in the drawing. Use finishing nails, and coat the mating surfaces with glue. Be sure to sink nail heads below the surface.

Cut out the lower shelf and lower sides, and nail and glue them in place, then install the floor, floor cleats, and base sides. With the exception of the lower shelf, these are all simple rectangles. Be sure all mating parts are square with each other as you go along.

Make up the front panel, rabbeting the edges as shown in the drawing. Next cut out the base front, mortise its edges, and glue and nail it in place. Install the nosing molding, using miter joints at the corner.

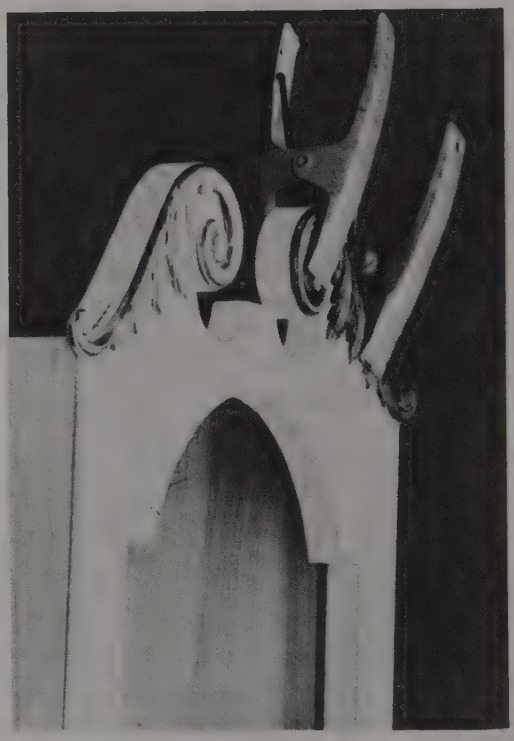


How major portions of clock are assembled.



Trace the carvings directly on the work to mark top cut.

Clamps hold the carvings in place until the white glue sets



This completes the lower section of the clock.

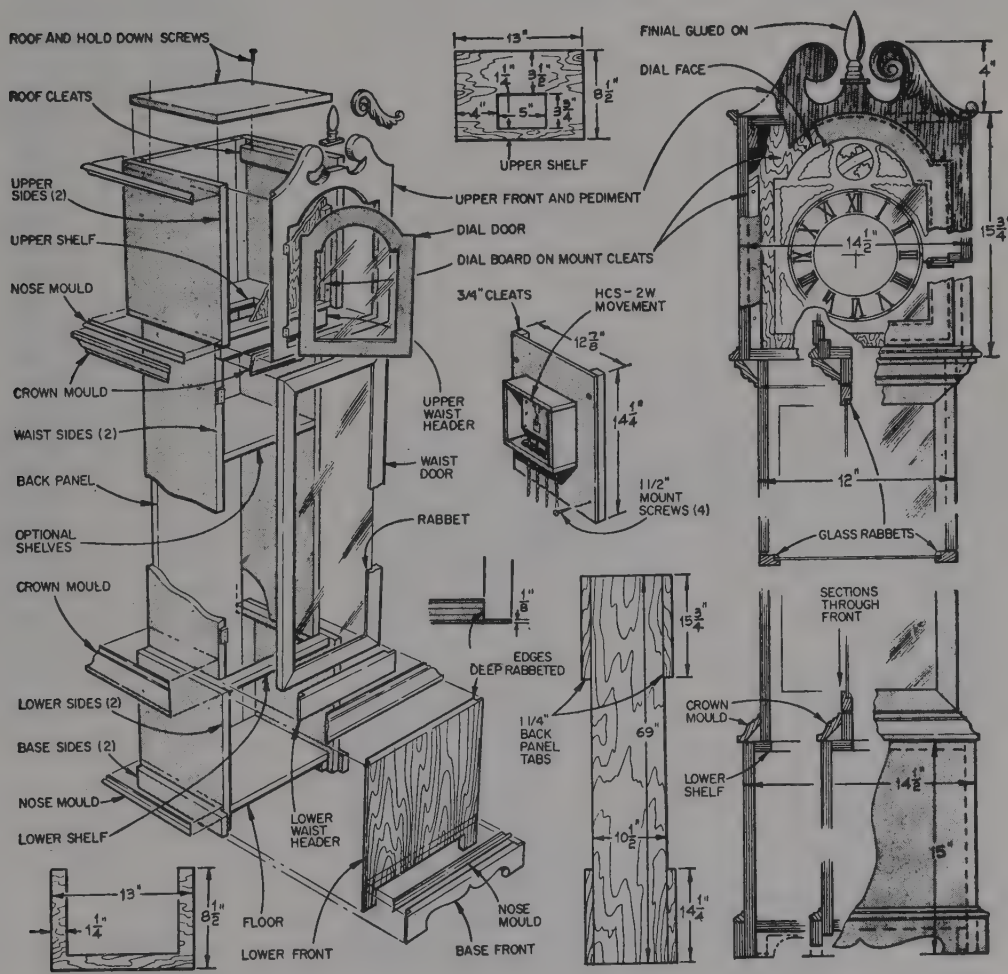
Next cut out and install both the waist sides. Use screws to attach the waist sides to the back panel, and to the lower shelf. Glue, of course, is used on all mating surfaces. Cut out and install the upper sides and upper shelf. The roof cleats can be glued and nailed in place at this time. Note that the side roof cleats do not extend to the forward edges of the upper side panels. Cut out and install the upper and lower waist headers.

The upper front is cut out next. Trace

the opening from a full-size pattern, or use the dial itself as a guide. As there are slight variations in carvings, use the pediment carving themselves to establish your cutting line. When the front has been cut out and sanded smooth, glue the carvings to the front. Be sure to allow the outer edges of the carvings to extend beyond the sides slightly, so they will blend with the upper nosing molding when it is installed.

Now you can mount the front of the clock, nailing it and gluing it in place. Upper and lower crown molding are installed next, and the finial at the top of the clock. These corners must be mitered at a 45 degree angle. With the addition of the upper nosing molding, the basic clock structure is complete. At this time, however, you can add shelves, if you are using an electric clock movement.

Now make up the dial board. Be sure the hole for the hands is centered exactly. Glue the dial itself on the front of the panel, and mount the movement on the back. The dial board is slipped into place from the top of the clock, and fastened in



place with four 1½-inch screws. The roof can now be fastened in place. Use screws, and do not use glue, as this provides the only access to the clock works.

The dial and waist doors are made up next. These can be of ¾-inch stock, with the inner edges rabbeted as shown in the detail drawing or with two layers of ⅜-inch stock. If you use the latter method, cut one piece to full size for each door. For the waist door, cut the second piece to the full outside dimension, but ¼-inch narrower around the inside. For the dial door, the second piece should be cut so that it fits easily inside the upper front panel, and its inner cutout should be ¼-inch narrower than the first door piece.

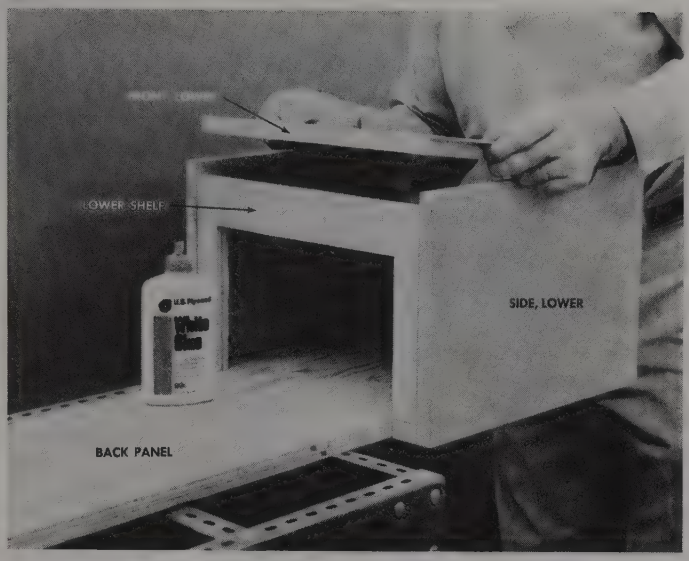
When the two pieces of each door are glued together, you will have a ¼-inch lip running around the inside edge, against

MATERIALS LIST

Quantity	Size and Description	Purpose
1	¾" 10½"x69" lumber of your choice	back panel
2	¾" 1¼"x15¾" lumber of your choice	upper back panel tabs
2	¾" 1¼"x15" lumber of your choice	lower back panel tabs
2	¾" 2⅝"x10-11/16" lumber of your choice	base sides
1	¾" 2⅝"x16" lumber of your choice	base front
2	¾" 9-15/16"x15" lumber of your choice	lower sides
1	¾" 14½"x15" lumber of your choice	lower front
1	¾" 14½"x19-9/16" lumber of your choice	upper front
2	¾" 9-15/16"x15¾" lumber of your choice	upper sides
2	¾" 8"x38¼" lumber of your choice	waist sides
2	¾" 2-1/16"x12" lumber of your choice	waist headers
4	¾" 8½"x13" lumber of your choice	shelves, roof and floor
2	¾" 1½"x5¾" cleats	roof side
1	¾" 1½"x13" cleats	roof rear
2	¾" ¾"x14¼" cleats	dial board
1	¾" 1½"x13" cleats	floor, rear
2	¾" 1½"x7¾" cleats	floor, side
1	⅜" 12⅞"x14¼" lumber of your choice	dial board
1	¾" 12"x15" lumber of your choice	dial door
1	¾" 12"x34" lumber of your choice	waist door
1	⅛" 9⅛"x12⅜" glass	dial door
1	⅛" 9⅛"x31⅛" glass	waist door
as needed	2½"x7' crown molding	
as needed	¾"x9' nosing molding	
	1" dia.x3½" finial	
	¼"x1"x1⅝" finial base	
	10"x13" dial	

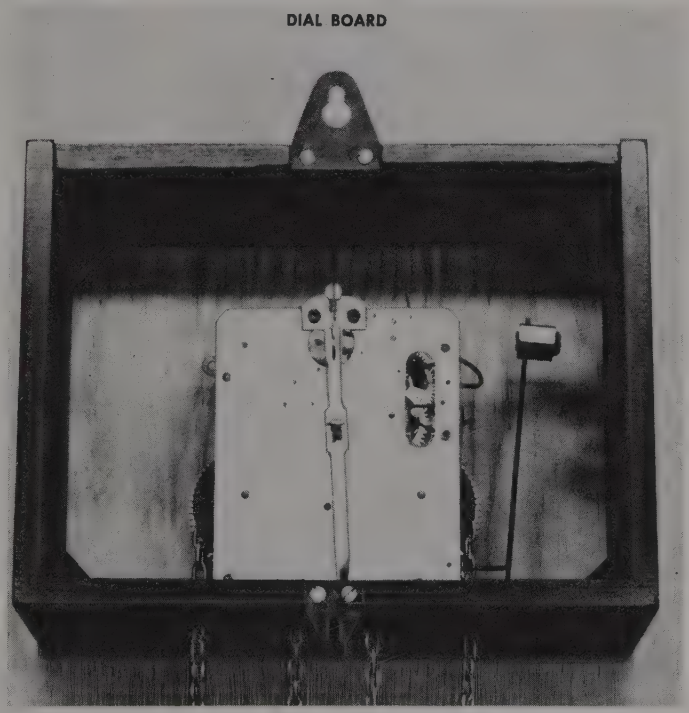
NOTE: Also need, clock movement, pediment carvings, base carving, hardware, glue, etc.

▲ *You may install shelves in body of clock if it has an electric movement. Door stock has 1/4-inch lip for glass which is held on with quarter-round stock.*



▲ *Use white glue to fasten front lower panel to base of clock.*

▼ *Dial board with clock mechanism attached is slid into place from the top of the clock. This movement is operated by weights, although an electric movement would serve equally well.*



➤ *This clock is somewhat different in design from the preceding one; it contains a hi-fi speaker.*

which the door glass rests. It is recommended that you have the glass cut to the proper shape by a glass dealer, unless you are experienced in this type of work. When the glass is installed, use ¼-inch quarter-round stock to hold it in place.

Next, you mortise for the hinges, and install the doors so they fit flush up against the waist and upper front.

Finally, check all the joints, and set any nail heads that protrude. Fill the depressions with wood putty, and you are ready to apply the finish. If you have an open-grained wood, use a paste wood filler before staining and varnishing. Your local paint dealer is your best source of information on suitable fillers, stains, and coatings.

This grandfather's clock does more than tell time! Deep down inside it contains a speaker—mounted in a modified tapered pipe which offers very bright tone reproduction as well as efficient acoustic output.

Why a pipe as opposed to the entire mid-section of the clock? Explanation runs this way: a pipe closed at one end produces third and fifth harmonics. But by placing the speaker a third of the way down, the third harmonic is eliminated. All things considered, the tonal results are remarkable. To be sure, a speaker with a larger cone would be even better, but we are limited to the confines of a well-proportioned clock.

Though the clock looks fairly complicated, it's actually extremely easy to build. It was designed so that even without previous experience anyone can easily build it. If you can build a box, you can make this grandfather's clock. It's that simple!

Decorative spindles as well as the movement and dial can be purchased. The movement in our clock is battery-powered and transistorized. It will run a whole year on a single battery.

If you own a table saw you can cut the plywood yourself; otherwise have your lumber dealer cut the panels for you. Most lumber yards will cut the panels without cost, though others have a minimal charge.

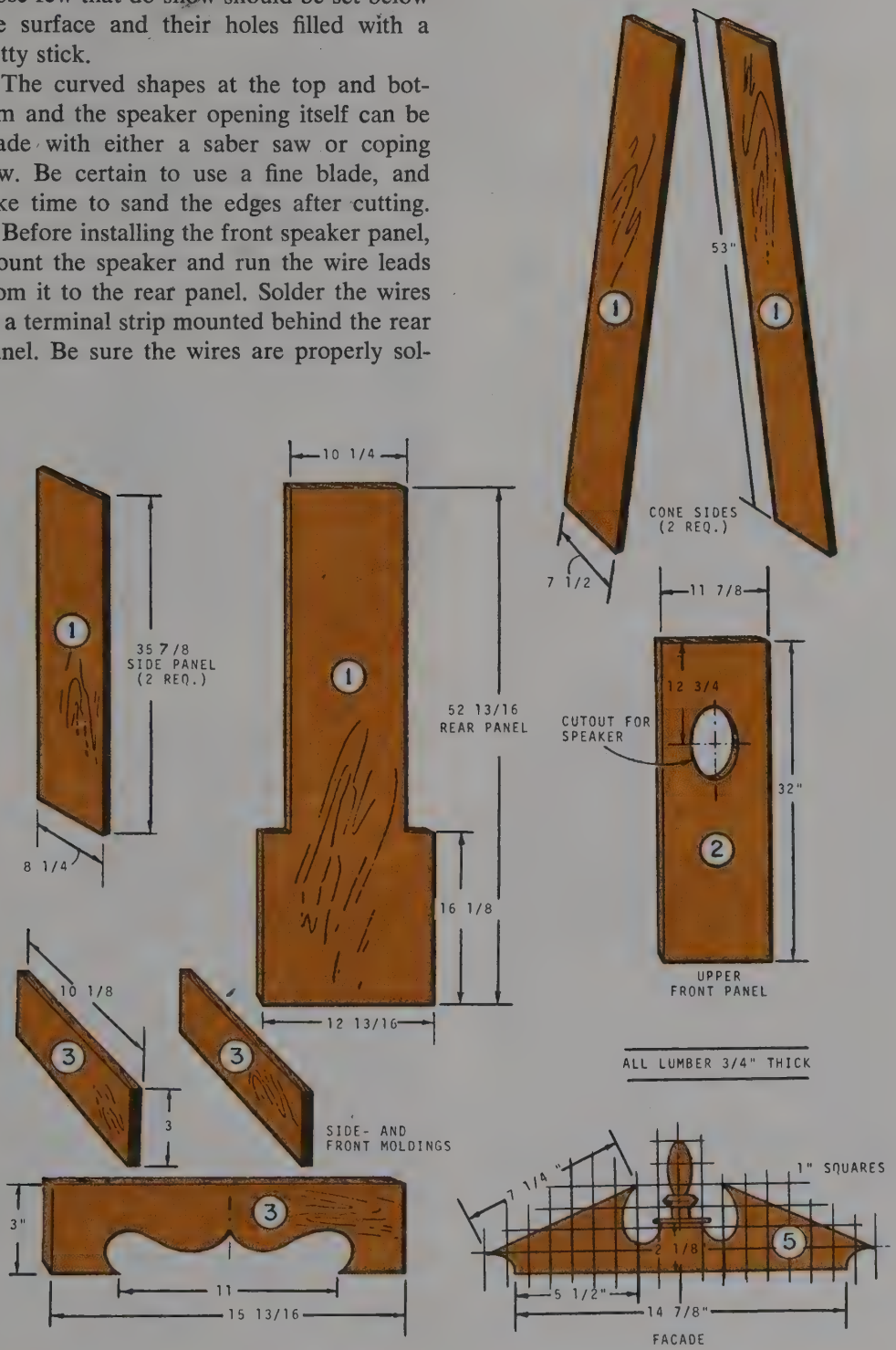
Butt joints are used throughout, eliminating fancy miters. Nails and glue combine to further simplify construction.

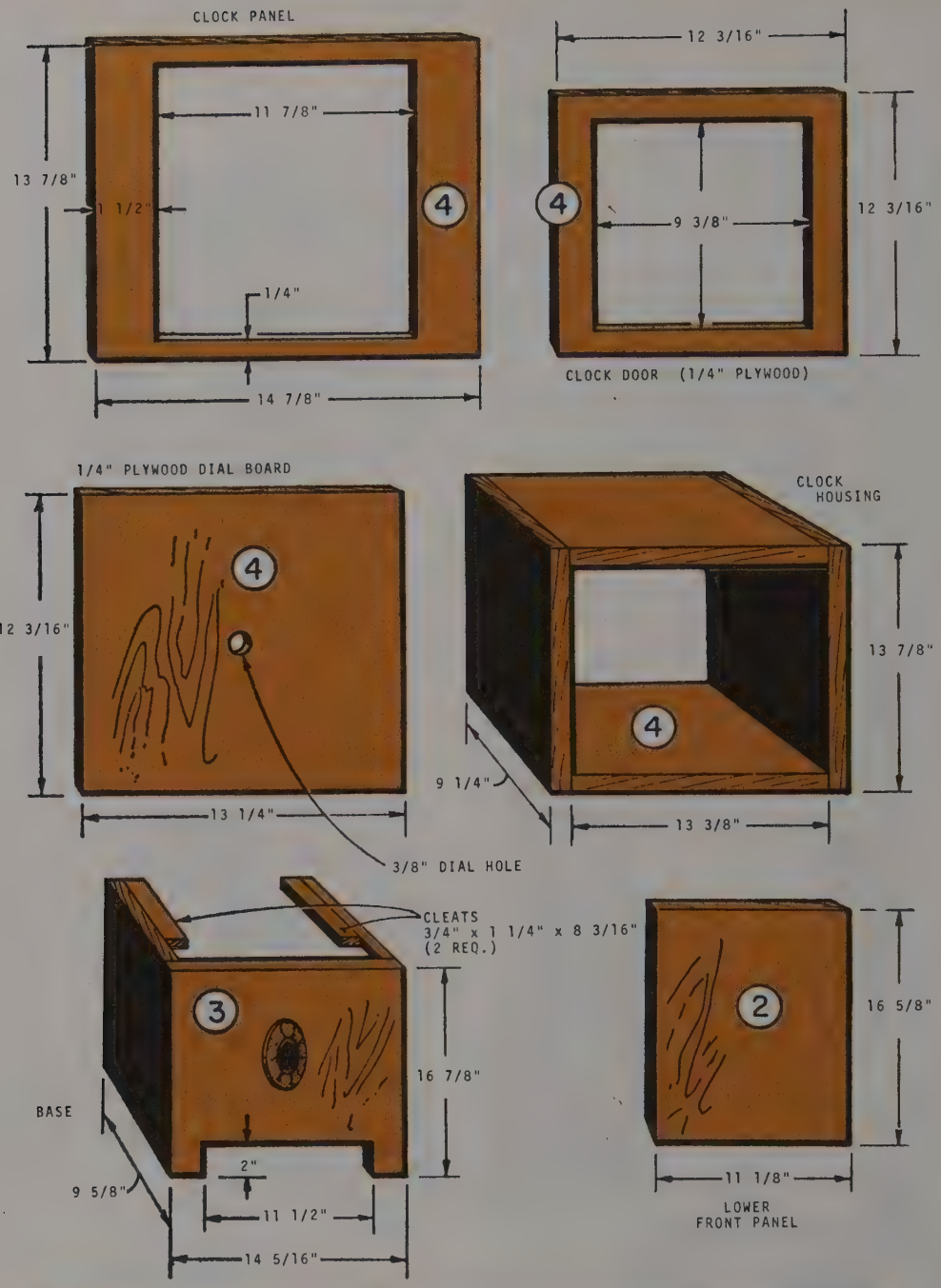
Start by assembling the cone sides to the rear panels. Run a bead of glue along the joint, then nail with 2-inch finishing nails. Most nails will be hidden, but

those few that do show should be set below the surface and their holes filled with a putty stick.

The curved shapes at the top and bottom and the speaker opening itself can be made with either a saber saw or coping saw. Be certain to use a fine blade, and take time to sand the edges after cutting.

Before installing the front speaker panel, mount the speaker and run the wire leads from it to the rear panel. Solder the wires to a terminal strip mounted behind the rear panel. Be sure the wires are properly sol-

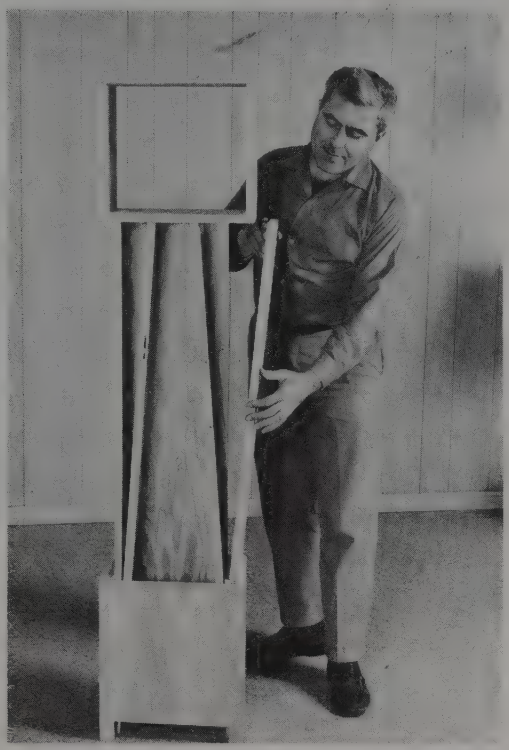




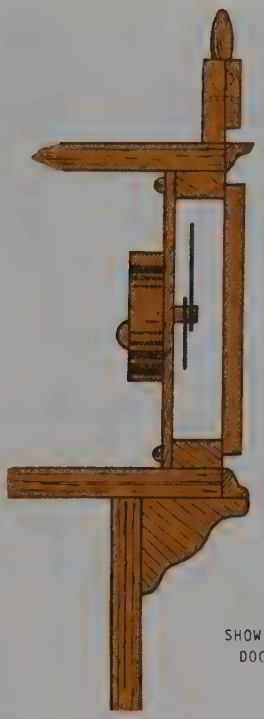
MATERIALS LIST

Quantity	Size and Description	Purpose
1	3/4" 4'x8' plywood or equivalent	basic unit
1	1/4" 4'x4' plywood or equivalent	clock panel, clock door and dialboard
1	5"x7" oval speaker (see text)	

NOTE: Also need, spindles, clock mechanism, dial, finial, decorative applique, 1 1/2-V battery, finishing nails, cove molding, glue, solder, grille cloth, terminal strip, etc.



▲ *Assemble the base, then glue and nail the side panels to the rear panel. Cutout at bottom of the base will allow sound from speaker to emerge from end of tapered pipe.*

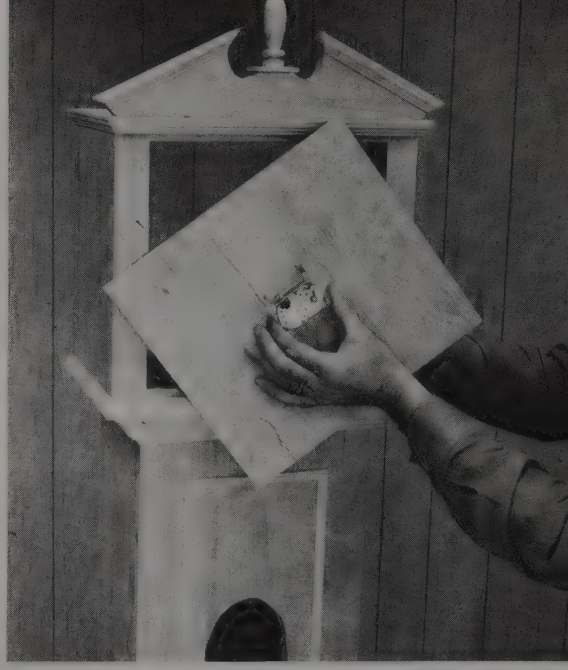


CUTAWAY

SHOWING DIAL BOARD
DOOR & MOVEMENT

▼ *Molding is attached to the base of the clock after the front base panel is in place. Cutout in front molding permits sound to escape.*

▲ *Outline of masking tape helps in installation of front panel molding. Note: speaker is installed on back of front panel before the panel is put in place. Run zip wire from the speaker terminals to the terminal strip on the back panel.*



▲ *Electric clock movement mounted on back of 1/4-inch-thick panel operates for year on one battery.*

▲ *Easiest way to apply cove molding and applique is with hot glue. It sets in 60 seconds.*

➤ *Mount dial on front of panel and insert the panel through the rear opening.*

dered, since the only access to the speaker after mounting the panel is through the opening at the bottom. And this is a very tight squeeze indeed!

The decorative molding is best cut with a simple miter box and hacksaw, available at hardware stores and lumber yards. Support the molding at the same angle as it will be mounted and cut with slow, steady strokes. To eliminate unsightly nails on the molding, use glue. Run a bead of glue along the joint, then quickly join the parts. The finial, spindles, and decorative appliques at the base are mounted in the same way.

The grille cloth is cut to size but not mounted until after the clock has been finished. Finishing depends on the wood used. If walnut, birch, or other cabinet woods are used, these can be stained, then given several thin coats of shellac. After the final shellac coat, rub down with fine steel wool, then follow with paste wax.

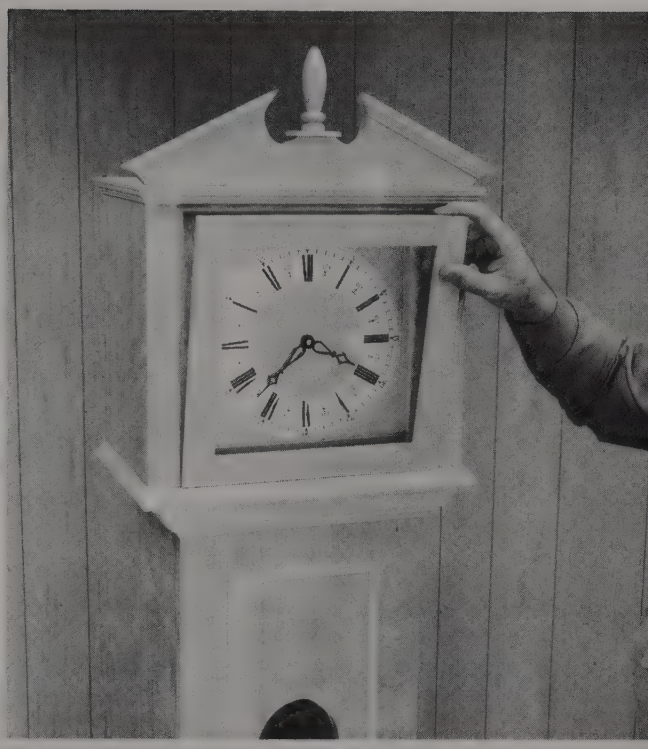
The grille cloth should be cut to fit within the opening provided. Brush on a coat of white glue that has been thinned down with water, then press the cloth firmly into place. The area of wood covered by the grille cloth shouldn't be stained or otherwise finished or the glue won't adhere properly.

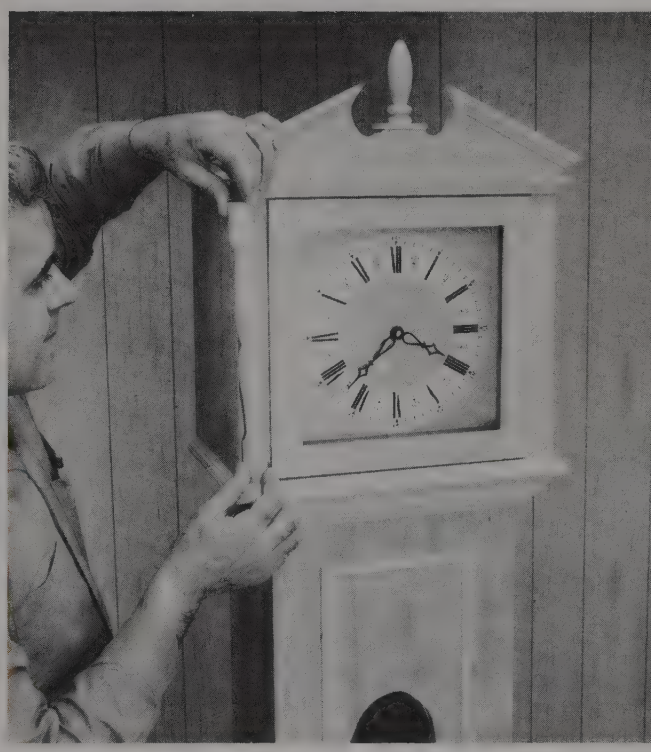
And thats it! You've just completed a functional, decorative addition to your home.

See also: FINISHING, WOOD; WOODWORKING.

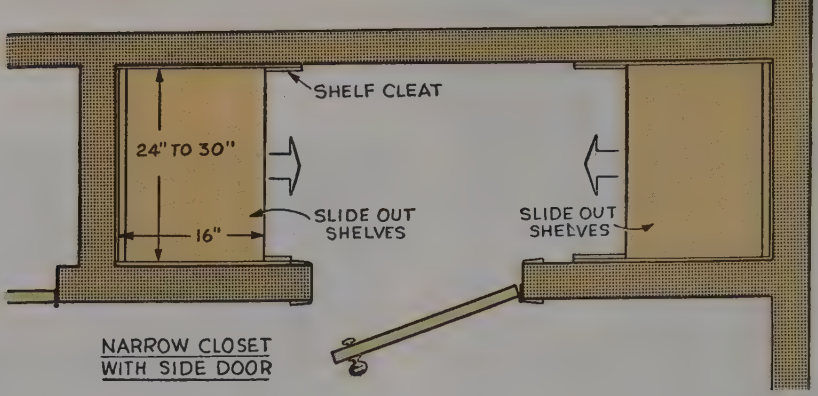
WHERE TO FIND IT

If your local dealer does not carry the carvings, clock mechanisms, dials, finials, spindles or applique they can be ordered from The Armor Co., Box 290, Deer Park, N. Y. 11729.



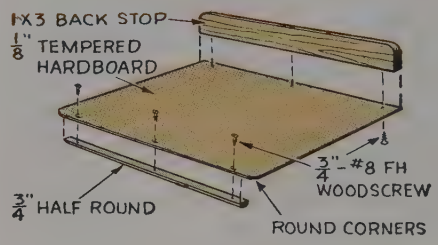


➤ *Ready-made spindles and finial decorate the front of the clock.*



Make Closet Space Do Double Duty

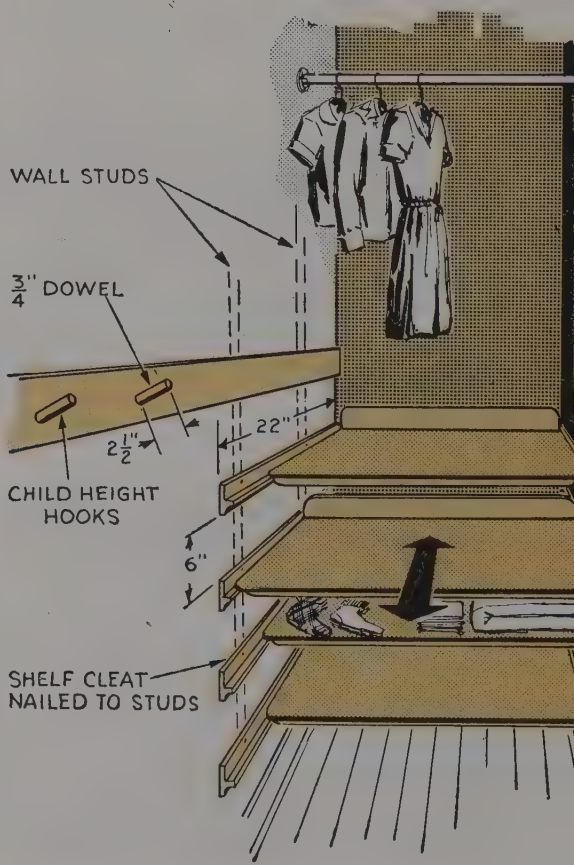
You can get extra use from a closet with a few simple changes



BY MAKING A FEW SIMPLE changes in a dead end closet you can use it for hanging garments and still have low shelf space for horizontal storage. You'll need several lengths of standard shelf cleats, some 1 x 3-inch lumber for backstops, a ¾-inch half-round molding for the shelf-drawer pull and a panel of ⅛-inch tempered composition board for the shelf-drawer pieces, some finishing nails and small screws. If it is a child's closet, you'll need a strip of chair rail molding and some ¾-inch dowel for the clothes hooks.

Cut the shelf cleats to needed length and nail to the wall studs, spacing the shelf-drawers about 6 inches apart. With the shelf cleats in place, cut and fit the composition board so it has about 1/16-inch clearance on the sides. Drill holes and countersink them for the screws; then fasten the half-round drawer pull and 1 x 3 backstop to each panel.

For the small fry, cut the chair-rail molding to fit the side wall of the closet; then drill ¾-inch holes on a slight angle and glue the clothes pegs in place. Locate the wall studs and nail the chair rail to the side of the closet at the proper height for your child.



clothes dryer: see washer and dryer
clouds: see weather

Four Cedar Closets You Can Build

Any of these storage units of fragrant moth-repellent cedar can be constructed in two or three weekends of work

YOU CAN BUILD any of the four cedar-lined closets illustrated here in a few weekends. Each is relatively simple to construct—no more than a box of ordinary stock and plywood with doors fitted and the interior lined with cedar boards.

The moth-repellent cedar requires no surface treatment, finishing or maintenance, other than a light sanding or rubbing with steel wool every few years to keep it aromatic.

You can get bundles of the fragrant wood from lumber yards specially milled for lining closets. The boards have tongue-and-groove edges and are ⅜-inch thick. They can be ordered in widths from two to four inches and lengths of two to eight feet, or in random lengths.

To build your storage unit, you can follow one of the designs here, or merely use them as examples, keeping the basic idea, but altering the dimensions to suit your needs and the space available in your house.

The paneling is attached to a wall by nailing, or in some cases by adhesive. When lining a closet wall, start at the base, placing the cedar board against the wall with the grooved edge down. Nail the board to the wall through the base of the tongue. When the first row is in place, simply push the boards of the second row on the first so that the groove in the bottom edge of an upper board mates with the tongue of a lower one. Then nail the upper board in place through the base of the tongue. Continue in this way until you reach the top. Trim the last board to fit and nail it through the face with finishing nails and sink the nails with a nail set.

When facing a floor or ceiling with cedar boards, start at the back of the closet and work outward. Helpful hint for closet builders: when practical, face the wall, ceiling or floor of your structure before assembly. It's easier that way.

In some cases, the use of an adhesive, or a combination of nails and adhesive, is recommended. The adhesive used comes in cartridges that fit in caulking guns. If you have any doubts, consult the dealer from whom you purchased the cedar.

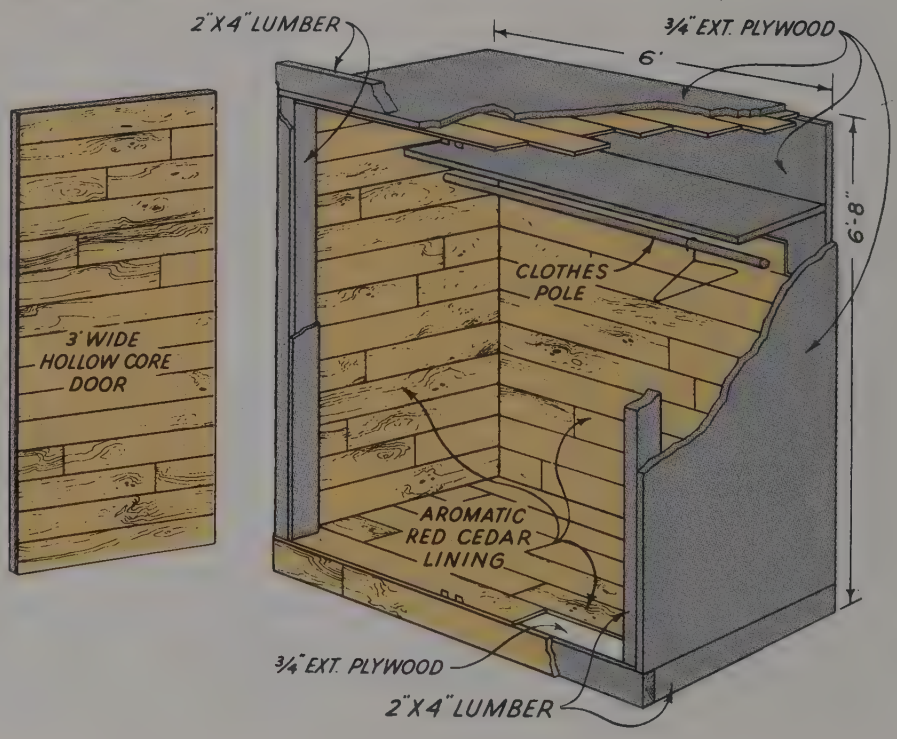
The simplest storage unit is a free-standing closet suitable for basement, attic or garage. It is fitted with two three-foot wide hollow-core doors. These require adhesive for attachment of the cedar boards because the face of this kind of door is too thin to hold nails well.

Start the closet by making a foundation of two by four-inch lumber laid on edge and nailed together at the ends. The width should be six feet and depth 30 inches. Make the closet six feet eight inches high.

Four Cedar Closets You Can Build

You can build a simple cedar-lined closet like this one in an attic or basement in a few weekends. The aromatic cedar lining repels moths —a big plus when storing woolens—and keeps the closet and its contents from getting a musty odor from long storage.

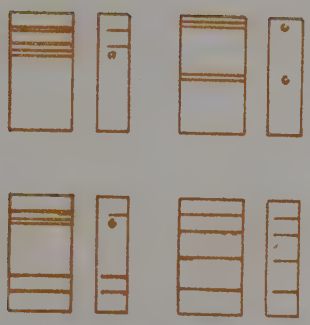
IT'S EASY TO ADD UNITS



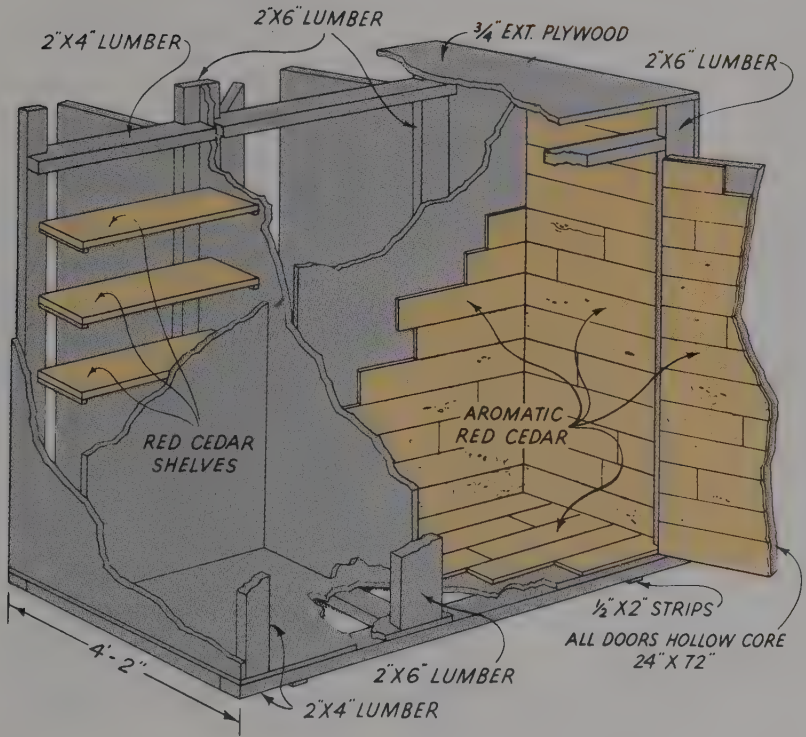
This simple two-door design is formed by a foundation of 2 x 4s with 3/4-inch plywood floor, walls and ceiling. Use 2 x 4s as corner posts for the hollow core doors and line the interior with cedar boards.

Four Cedar Closets You Can Build

This room divider is actually two wide closets back to back, with three doors on each side.



ALTERNATE INTERIORS

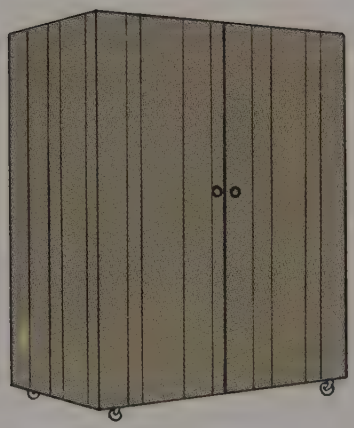


Construct the cedar-lined room divider storage unit as shown in this drawing. If the divider is to be in a basement, raise the foundation off the floor with ½ x 2-inch wooden strips.

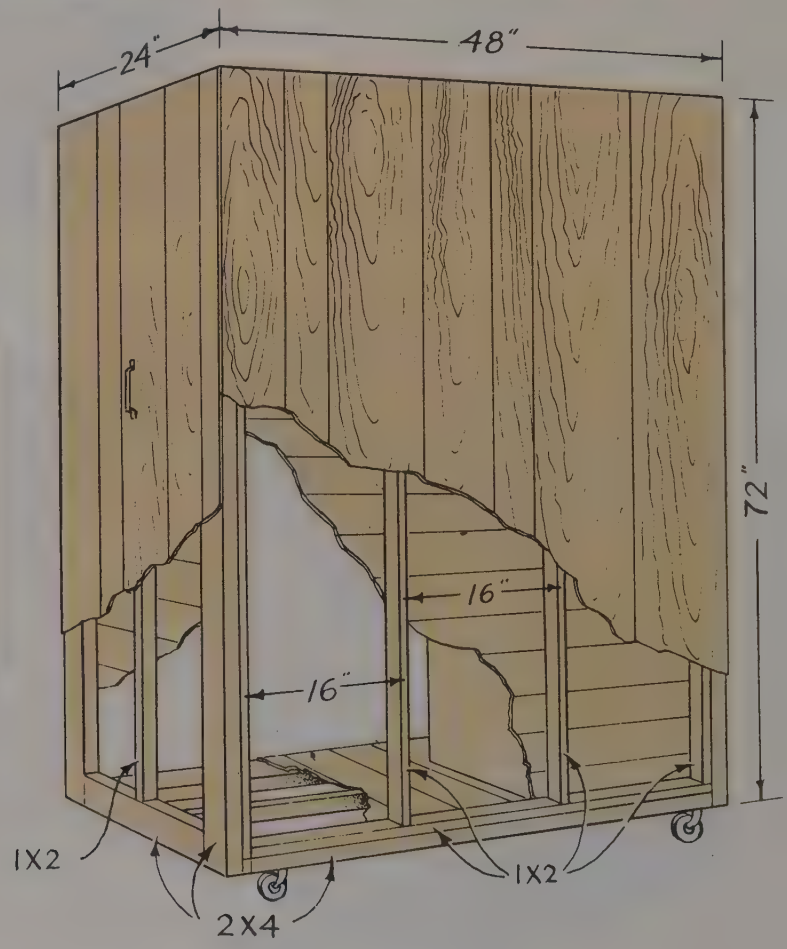
Add to the foundation, in this order: floor, side, back side and ceiling, all cut from ¾-inch exterior plywood.

Nail a vertical 2 x 4 in each front corner to support the doors. Then line all interior surfaces with random lengths of cedar and add a closet pole and a cedar shelf. Line the doors with cedar and install them last, using magnetic catches to keep them shut.

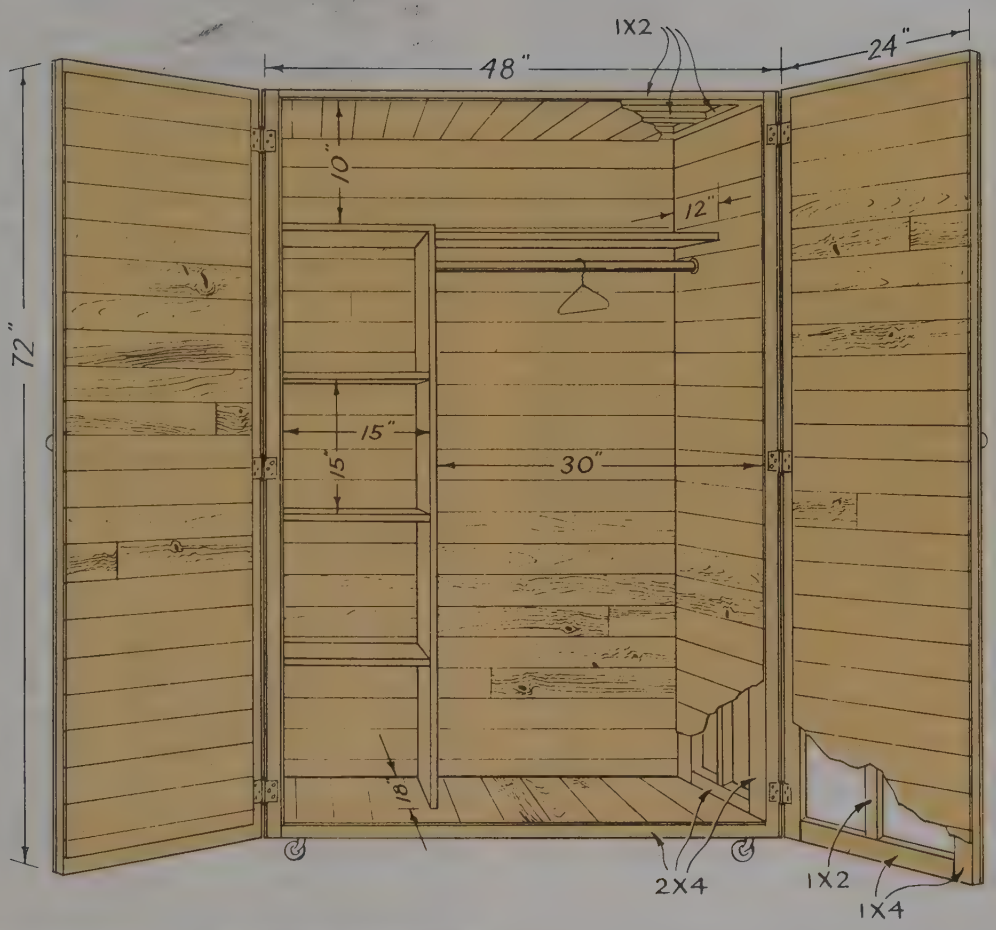
Roll-away closet is mounted on heavy duty casters. When not packing or unpacking it, push it out of the way. Interior is cedar-lined; the exterior is prefinished plywood.



FRONT VIEW



REAR VIEW



Roll-away closet is constructed in much the same way as the other units. However, the frame is stronger since the closet endures more stress than the stationary units.

Also, use weather-stripping around the doors to keep the closet relatively air tight.

More complex than the simple free-standing unit, is the basement room divider storage unit with three doors on each side. It's actually two closets back to back.

Start by building a foundation of 2 x 4s laid flat and nailed at the edges. Include a crosspiece across the short dimension from the base of one 2 x 6-inch door post to the other. If the storage unit is located in a basement, place the foundation on ½ x 2-inch strips.

To continue construction, use 2 x 4s, 2 x 6s and ¾-inch exterior plywood as shown in the drawing. Line the interior walls, floor and ceiling as well as the insides of the doors with red cedar. Also use red cedar for shelving.

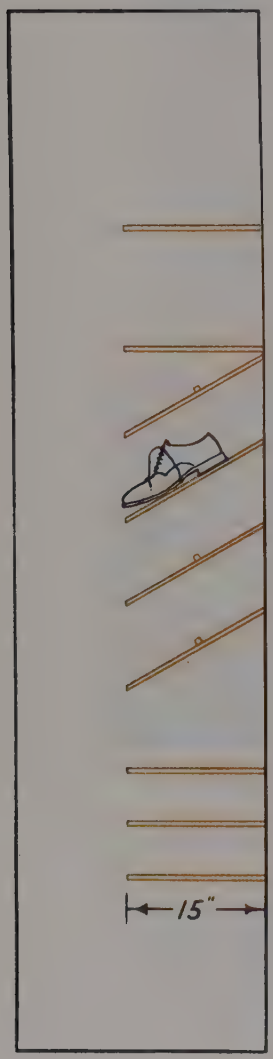
A roll-away closet is a convenience where you are cramped for space. When it's not being packed or unpacked it can be pushed out of the way.

Because the roll-away unit must withstand the stress of being pushed or pulled, it requires a somewhat sturdier frame than the stationary closets. Build the frame as shown in the drawing. For convenience, build the foundation and the three walls as separate units, then assemble them. Line the interior and the insides of the doors with cedar. Cover the outside with prefinished plywood. The casters are screwed to the foundation 2 x 4s at the corners. Use heavy-duty casters, because the roll-away closet is heavy.

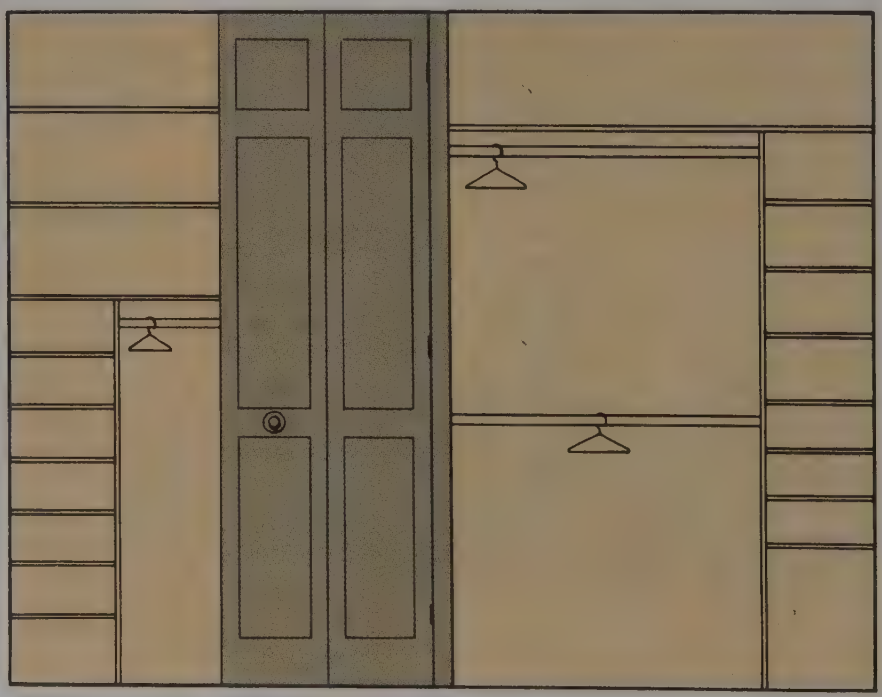
The doors are made of 1 x 2 and 1 x 4 frame with cedar on the inner surface and prefinished plywood on the outside. Use three hinges to hang each door and install magnetic catches to keep them shut.

Building a wall-to-wall closet in a master bedroom is simplified by the fact that part of the room itself forms the floor, ceiling, walls and back of the closet. All you have to do is line the walls with cedar, nailing the boards to the plaster. In this case, drive the nails through the face of the boards rather than through the tongue.

Install a center partition of plywood, a center door post and two end doorposts. Then equip the closets with poles and shelving according to your requirements and fit it with two sets of bifold doors. Use cedar boards to build the shelves.



Wall-to-wall closet is relatively easy to build; the walls, floor and ceiling of the existing room form most of the closet, the front consists of three doorposts and two sets of bifold doors. Line the interior with cedar simply by nailing cedar facing to the existing walls. Then install a center partition, closet poles and shelves of cedar, according to your needs. Install the posts and doors.



How to Maintain Your Car's Clutch

Keeping this device in tip-top shape will add thousands of miles to its useful life

The manual clutch is anything but obsolete. Millions of motorists prefer it to the more expensive and less reliable automatic transmission.

MOST PASSENGER CARS being sold today have automatic transmissions driving through a torque converter, thus eliminating the need for a clutch, but manually operated friction clutches are still in millions of cars on the road, and sports cars and economy cars—both European and American—couple their engines to the transmissions with friction clutches. Fortunately, these precision mechanisms are built to stand up under an amazing amount of abuse before they fail.

First, let's understand why a clutch is necessary. Unlike a steam engine or an electric motor, a gas engine will not start from rest under load, since its power depends on the number of power strokes per unit time. In other words, it has to be turned up to cranking speed from an outside source (a starter motor) and reach a certain speed, free from load, before the load can be applied. Since the engine must be *kept* turning at an efficient speed—a speed higher than that at which the wheels should turn—the power must be applied to the wheels through a reduction gearing, the ratio of which is variable and under manual or automatic control. Also, suitable reverse gearing must be provided, since a conventional gasoline engine rotates in only one direction. These gear changes must be made while the engine is temporarily disconnected from the drive shaft or transmission. Further, as a matter of convenience, the engine must be enabled to keep running while the car is at rest (as at traffic lights or crossings). All of these functions are taken care of by the clutch.

Automotive engineers do everything they can to reduce friction in an auto's moving parts, yet a car would not budge an inch without it. For it is friction between the clutch parts, under spring pressure, that makes the drive shaft turn with the engine and propel the car.

The basic idea of driving a spring-loaded disc through friction, despite all the design changes over the years, remains unchanged. Notice, in particular, the effect caused when the driven disc is worn thin. The same thing happens in any conventional clutch, but it is self-compensating for normal wear.

clutch switch: see engine
coaster brakes: see bicycles

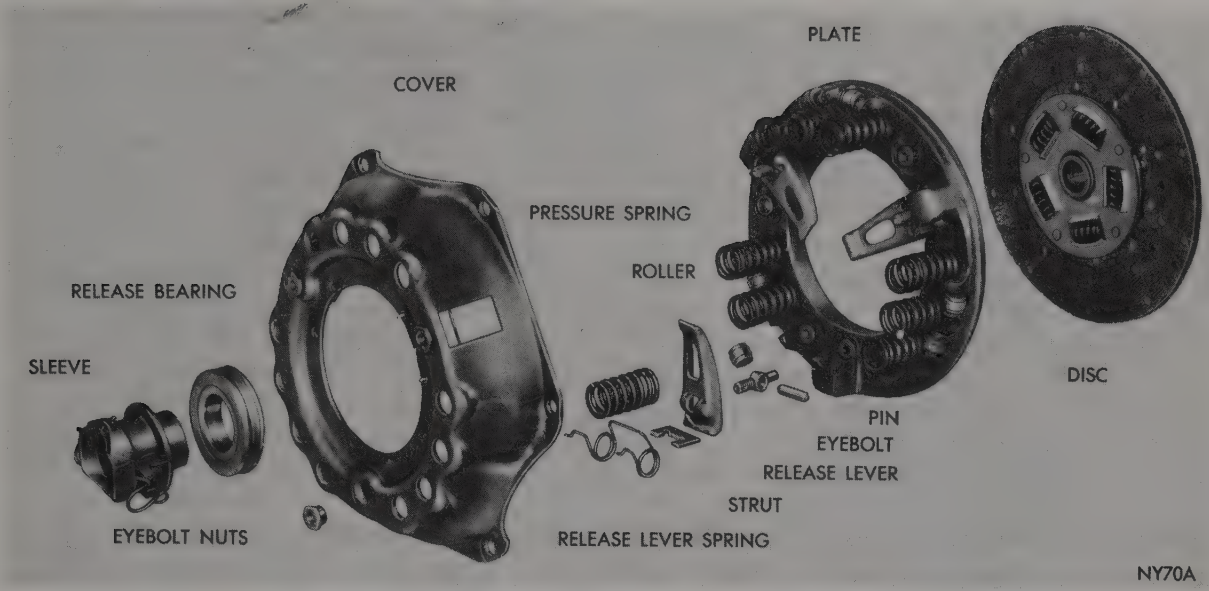
(The spring expands.) Also, the free play in the pedal can be adjusted. Of course, there may come a time when the friction disc facings are completely worn out and have to be replaced. If sensible operation methods are followed and excessive use avoided, however, there is no reason why the entire clutch should not last for the life of the car.

Almost all clutches are single plate designs, though they may vary from one another in small details. When pressure on the clutch pedal forces the release-fork rod back against the release fork, it pivots on a ball-socket in the pressure-plate cover and moves the release (throw-out) bearing against the release levers. These levers pull the pressure plate back against spring pressure and allow the clutch-driven plate to rotate freely between the face of the flywheel and the pressure plate. Except for the release bearing and release yoke, the entire clutch assembly rotates with the flywheel and is, from a functional standpoint, actually a part of the flywheel. Powerful springs push the entire assembly together, squeezing the friction disc between the pressure plate and flywheel when the clutch is engaged. When disengaged, the pressure plate is pulled backward so that the friction plate floats free between the flywheel and pressure plate. Thus, no power is transmitted to the main drive-gear shaft. The release levers are operated when the clutch release bearing is pushed against them by the forked release yoke. When pedal pressure is released, it lets the release bearing slide backward so that the springs in the pressure plate engage the clutch plate.

The release levers on some clutches are fitted with centrifugal weights to increase pressure at high engine speeds. One of the clutches illustrated has these weights. As they tend to fly out with increasing force at higher engine speeds, they force the levers to bear more strongly against the pressure plate, increasing the force holding the clutch disc. This arrangement, supplementing the springs when more pressure is needed, allows lighter springs to be used in the pressure plate, reducing the force necessary to operate the clutch pedal at low engine speeds. To illustrate, the total spring pressure may be 1,000 pounds, while at high engine speed (say 4,000 rpm) the pressure is increased to nearly 2500 pounds. The spring pressure in this case is more than enough to start the car in motion, while the effort necessary to operate the pedal is reduced about 50%. Such an arrangement stands up better under the treatment of drivers who race the engine and let in the clutch violently.

Another method of reducing the pressure required to depress the clutch pedal is used on Dodge and Plymouth cars. Here, the pedal is suspended from above and is linked to the clutch release fork in such a manner that it moves part of the linkage to an "over-center" position where a spring assists in depressing the clutch. If you plan to do much work on your car, including clutch adjustments, write to the manufacturer for a price on a service manual. Cost is a few dollars, but it will tell you enough about your car to save hundreds. The Plymouth service manual, for example, will also tell you that if the clutch release-fork rod is adjusted so there is $\frac{3}{16}$-inch play between the fork and the release bearing, the clutch pedal will automatically have the required one inch of free play.

Friction discs in clutches are built with a spring-cushioned hub. These damper springs take up the shock of engagement and smooth out the torque impulses of the engine before they reach the splined hub and transmission shaft. Observe that the hub floats free in the assembly and is driven through the springs by the friction-faced discs. This type of construction is especially important because cars flexible engine mounts are designed to prevent engine vibration from being transmitted to the



Typical modern clutch assembly. Cover and plate assembly, shown disassembled, is supplied as a single part; so is release bearing and sleeve (also known as throwout bearing assembly).

chassis of the car. What happens is that the engine bounces back and forth in its mounts when the clutch is engaged. Late-model cars often have torque rods, or a torque-absorbing thrust face on the rear motor mount, but in an older car with worn mounts, clutch chatter can be a problem. Before blaming your clutch for a chatter problem, however, check your motor mounts. They can be replaced a lot more easily, and for much less money, than can a clutch disc. When motor mounts are in good shape, the cushion springs in the friction disc eliminate chatter by permitting the friction facings to stay in contact during the fore-and-aft oscillations of the engine.

When a clutch is disengaged, it isn't necessary that the driven disc be separated from the driving members by any great distance. In fact, the distance that separates the parts in a disengaged clutch is almost microscopic—usually about .015 inch. You can see, therefore, why it is so important that the working parts be in correct alignment and free from warps or other defects. Any such faults will cause drag, chattering and other troubles. The pressure plate must travel about .090 inch (about $\frac{3}{32}$-inch) backward to completely released position. After taking up about 1½ inches of free play, the pedal must be pushed downward about 4½ inches to produce this movement. The standard ratio for this action is 50 to 1.

As you ease back the pedal to let in the clutch, the pressure plate moves forward and pushes the friction disc toward the flywheel. The cushioned facings take up the load and start the car in motion even before the springs have exerted their full force. Thus, they are still under control of the driver and a smooth start is effected. To keep the release bearing out of contact with the release levers, a definite amount of play is provided in the clutch pedal. This play becomes less as the facings wear, since the inner ends of the levers move closer to the release bearing. If neglected, they would finally push against the bearing with suf-

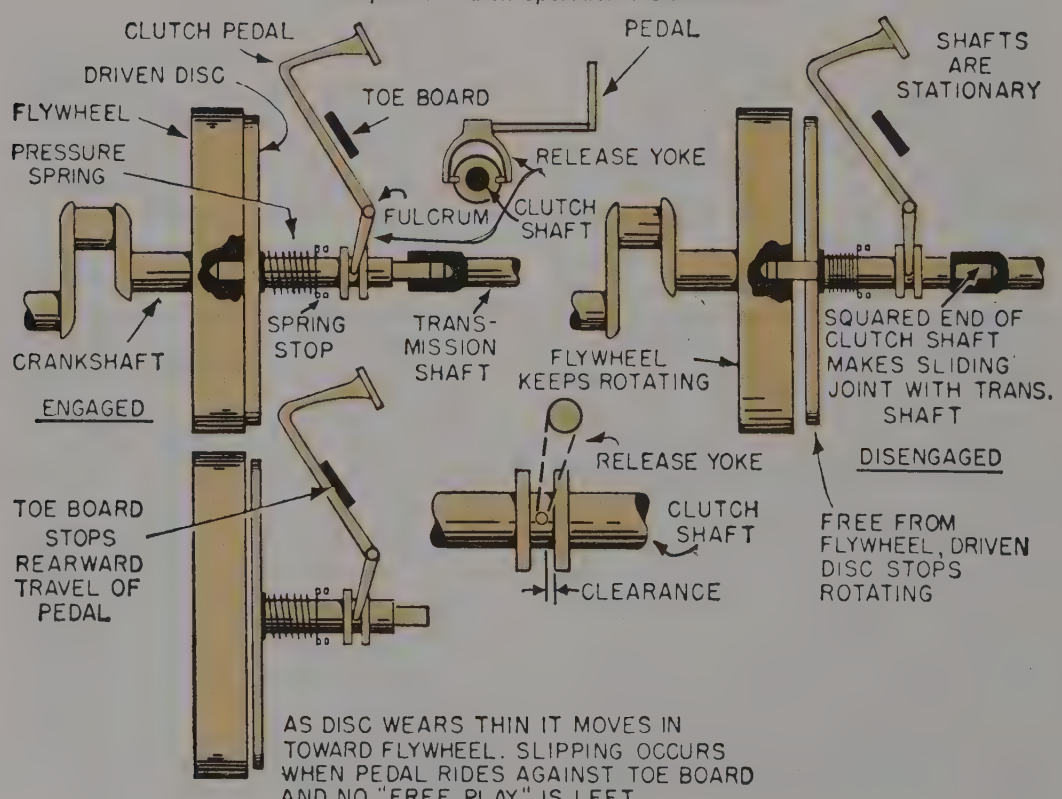
ficient force to let the clutch slip, for the effect is the same as if the bearing were pushed against the levers by the pedal. However, a simple adjustment, which takes only a few minutes, will restore the clearance essential to efficient operation.

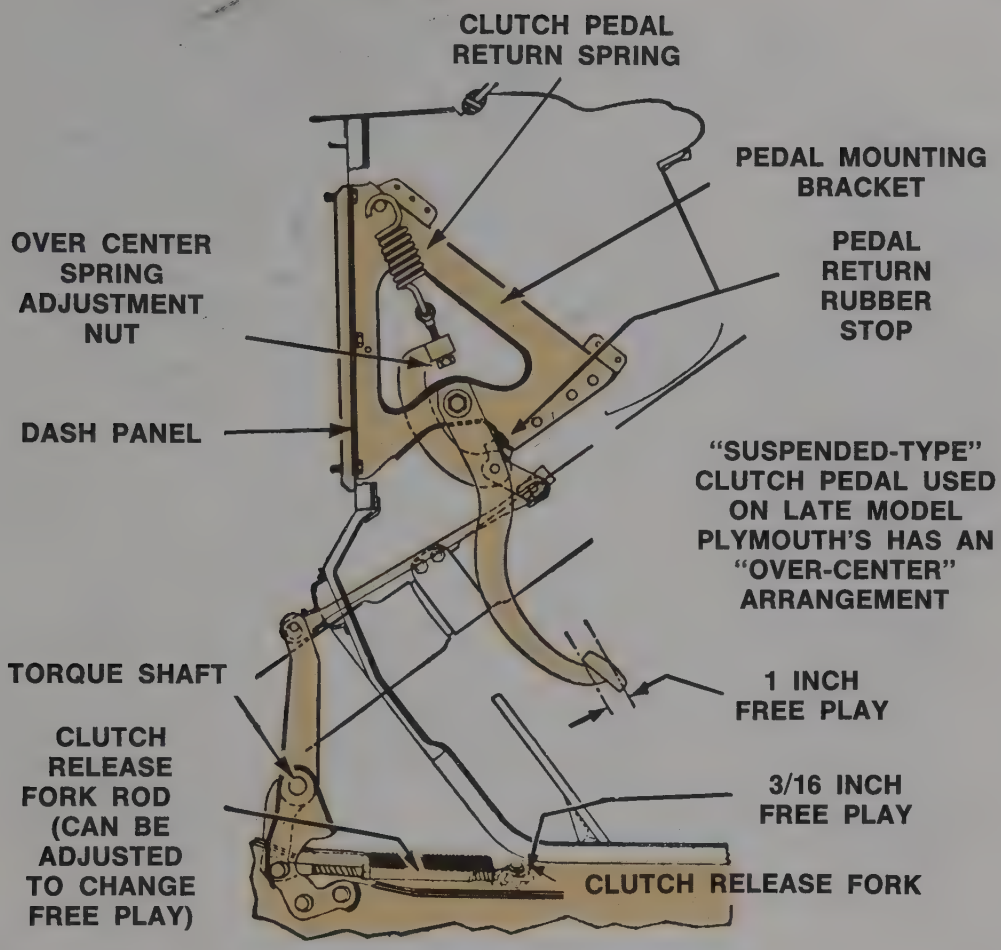
If the pedal shank hits the underside of the floor board (or the overhead bracket, in the case of suspended pedals) about the time the clutch is "engaged," it may not actually be fully engaged, and slipping will result, growing worse as the facings wear. The effect is the same as the notoriously bad habit of "riding the clutch." Just the weight of your foot on the pedal, especially if there is very little free play, exerts a powerful leverage and may reduce the effective spring pressure enough to cause slipping.

Slipping, by far the most common clutch trouble, not only wastes power and causes rapid wear, but also produces other bad effects. Anyone familiar with machinery knows that maladjustment, if neglected, leads to other trouble that aggravates the original condition. Nothing proves this point more than a slipping clutch. Beside the wear just mentioned, destructive heat is generated. This heat may warp or score the parts, burn the facings, or ruin the temper of the springs and weaken them, all of which combine to cause more slipping.

This can be further accelerated by heat cracks formed on the flywheel surface. These cracks expand as the clutch slips and present tiny but sharp edges that chew up the friction facing in short order. In this case, the flywheel must be replaced.

Principles of clutch operation are illustrated.

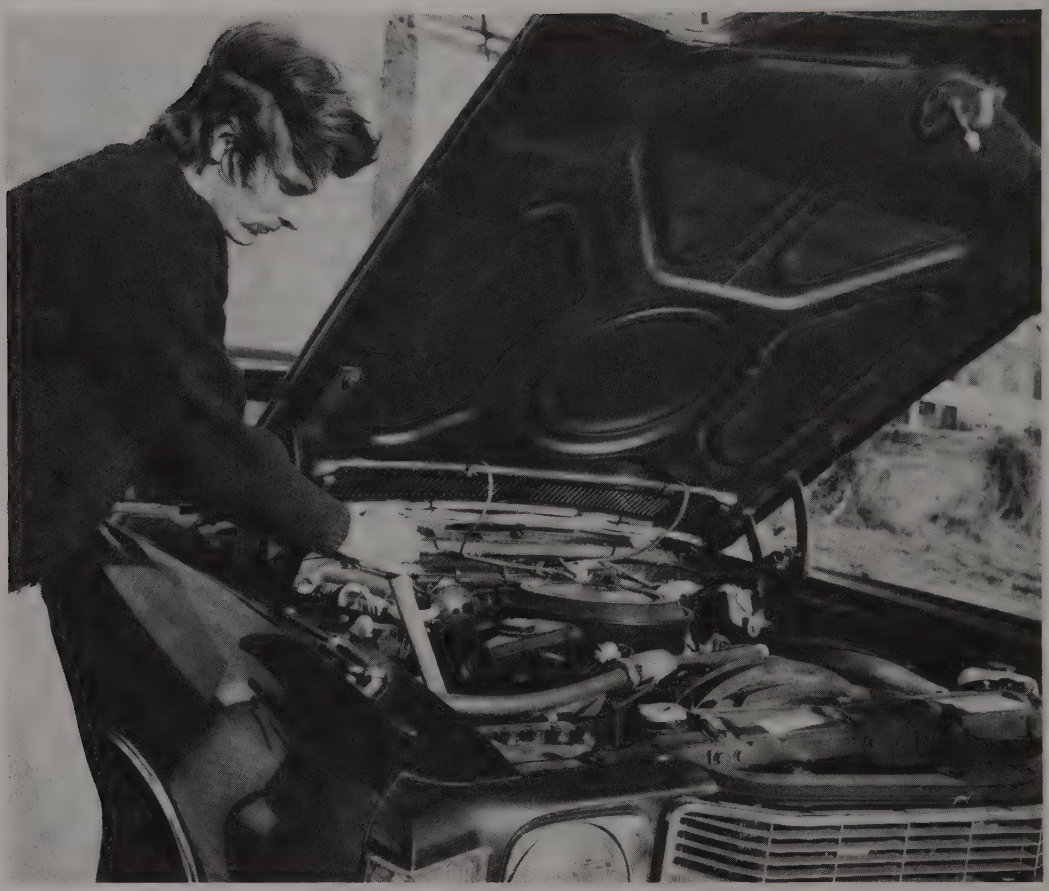



CLUTCH PEDAL RETURN SPRING
PEDAL MOUNTING BRACKET
OVER CENTER SPRING ADJUSTMENT NUT
PEDAL RETURN RUBBER STOP
DASH PANEL
"SUSPENDED-TYPE" CLUTCH PEDAL USED ON LATE MODEL PLYMOUTH'S HAS AN "OVER-CENTER" ARRANGEMENT
TORQUE SHAFT
1 INCH FREE PLAY
CLUTCH RELEASE FORK ROD (CAN BE ADJUSTED TO CHANGE FREE PLAY)
3/16 INCH FREE PLAY
CLUTCH RELEASE FORK

This is over-center spring design used to reduce pedal effort.

A simple turnbuckle arrangement is the usual provision for pedal adjustment. When checking for free play in a clutch pedal, don't mistake the pull of the pedal return spring for the pressure-plate spring tension. (To make sure you do not, disconnect the spring while making this test.) If you listen carefully, you can hear the release bearing when it strikes the release levers. The exact amount of free play may be specified differently by various manufacturers, but a safe amount is 1 or 1½ inches of free travel before the levers and bearing make contact. Normal wear is so gradual that you may not notice it until actual slipping occurs. Warning is given, however, by the fact that complete engagement comes nearer and nearer to the upper limit of pedal travel.

In making adjustments, avoid the opposite extreme—too much free play—for then the pedal can't be pushed down far enough to free the clutch completely and it drags. Since there is then enough contact



▲ *What may seem to be clutch problems may be caused by weak engine mounts. Check mounts with pry bar by trying to rock engine side to side. Replacing mounts is not a difficult job, but it does require good jacking, as the engine must be jacked up off the mounts in order to pull them out and install new ones.*

between the parts to keep the friction disc rotating, the gears clash—making shifting difficult and noisy—and doing the transmission gears no good. While the drag may not be enough to move the car when the transmission is in gear and the pedal is depressed, the friction disc, being held stationary under these conditions, will generate the same ruinous heat and disastrous results as it will when slipping.

If the adjusting nut is the self-locking type, it may give trouble by losing some of its self-locking quality. If the clutch adjustment refuses to "hold," you should try taking apart the adjusting mechanism, putting a second nut up against the original, and locking the two together in the correct position.

However rugged in construction, a clutch was never designed for continuous operation, it being assumed that it will stay engaged during most of the car's operating period. Neither the pilot bearing nor the release bearing will stand up under prolonged use, for no method is provided for positive lubrication of these parts in most clutches.

To illustrate, the release bearing turns only when you depress the pedal and push it against the rotating release levers to disengage the clutch. It may be either a plain

thrust bearing of graphite, or a ball bearing or roller type. In any case, if the release levers are in constant contact with this bearing, it will spin all the time the engine is running. Finally, it becomes dried out and damaged and screeches a protest that can be heard for blocks. The same fate is in store for the pilot bearing in the end of the crankshaft whenever excessive use of the clutch is practiced. High temperatures prevail in this part of the clutch assembly and the bearing operates only when the speeds of the engine and clutch shaft are not synchronized, as when the engine is running with the clutch released and the transmission is in gear.

If the car is standing still, the bearing will turn around the stationary shaft. Or, if it is rolling very fast under the same conditions, as when coasting, the shaft will be turning faster than the engine, and, again, the bearing will be in operation. The final result of such treatment is that the bearing will become noisy or bind on the shaft end, causing the same effect as though the clutch were dragging.

The idea is to keep your foot off the clutch pedal at all times except when starting, changing gears or stopping. Even prolonged waits at traffic lights and crossings with the car in gear and pedal depressed should be avoided. In such instances, it is

CLUTCH TROUBLE-SHOOTING CHART

Condition	Possible Cause	Remedy
SLIPPING	1. Improper pedal adjustment	1. Adjust to provide free pedal travel to 1 to 1½ inches
	2. Oil soaked clutch facings, badly worn or damaged facings	2. Replace driven plate
	3. Sticking pressure plate	3. Check release levers for free action, also check fit between cover plate indentations and drive bosses on pressure plate
	4. Weak pressure springs	4. Replace pressure springs
	5. Sticking release sleeve, sticking cross shaft on which release yoke is mounted or retarded return travel of clutch pedal	5. Clean and lubricate bearing surfaces on release sleeve and cross shaft. Check clutch pedal movement and pedal return plate
	6. Distorted pressure plate	6. Replace pressure plate
GRABBING	1. Defective, worn or glazed clutch facings	1. Replace driven plate
	2. Sticking pressure plate	2. Check release levers for free action, also check fit between cover plate indentations and drive bosses on pressure plate
CHATTERING	1. Bent or badly worn driven plate	1. Replace driven plate
	2. Oily clutch facings or facings which have become flaky from heat	2. Replace driven plate
DRAGGING	1. Bent driven plate or oily facings	1. Replace driven plate
	2. Excessive free travel of clutch pedal	2. Adjust clutch pedal free travel to 1½ inches
	3. Badly worn release levers or other release mechanism parts	3. Replace worn parts
	4. Defective or damaged splines in driven plate hub or on transmission clutch shaft	4. Clean and remove burrs or replace parts if defective

better to put the transmission in neutral while you are standing. This is a good safety precaution, too, against damage to the gears if you get a bad bump from the rear and your foot slips off the clutch pedal. Further, always make a practice of starting the engine with the gears in neutral.

Other troubles that may cause rough or faulty operation include worn splines in the hub of the clutch disc, broken or weak damper springs, rough, glazed or broken facings, or grease or oil on the surfaces. These are all infrequent. A leaking rear main bearing in the engine sometimes will let oil leak through onto the clutch facings. The solution here is first to replace the bearing before repairing the clutch. Any of the faults mentioned will cause grabbing, drag or chattering. Rarely will a clutch stick or fail to disengage. Burned grease or gum will make the facings adhere to the flywheel and pressure plate. Also, there is the remote possibility of breakage in the release linkage or adjacent parts.

Many clutches will last for 100,000 miles or more in the hands of a careful driver, while continuous abuse may necessitate complete replacement after 5,000 miles. In other words, care pays off in long performance.

See also: PARTS REPLACEMENT, ENGINE.